Pleasure-seeking people and peaceful societies: a psychologist's view

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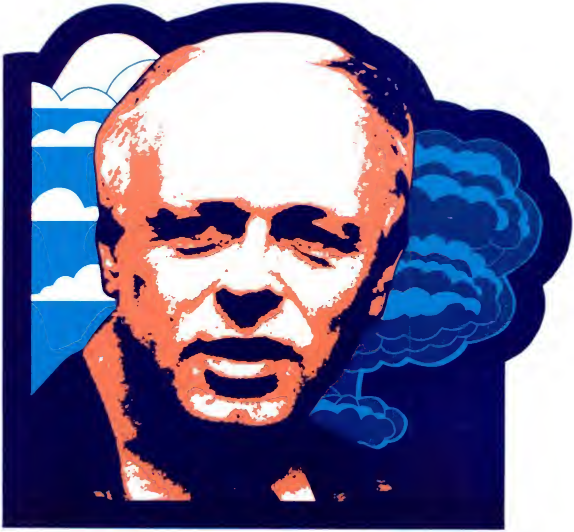

ANDREI SAKHAROV ON PEACE AND WAR

The efforts of the whole world will be needed to deal with the rising catastrophe of hunger and poverty in India and other nations of Asia, Africa and Latin America. One of the most promising of those efforts is Pugwash, an organization of scientists from East and West who meet annually to consider critical world problems and make recommendations to their governments. Out of the Pugwash conferences have come the nuclear test-ban treaty, disarmament proposals and new approaches to such urgent problems as the energy crisis and environmental protection. In January the Pugwash scientists will be meeting in Madras, India, to help enlist science and technology in long-term, life-saving projects for the nations of the Third World. But many distinguished scientists cannot attend unless travel funds are provided. Your contribution will help insure the success of this important work.

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Scientific Elite

The articles by Joel Primack and Frank von Hippel in the *Bulletin's* special report on Nuclear Reactor Safety (Sept. 1975) are in my view the strongest arguments yet for excluding the 'experts' from the nuclear power controversy. They are classic illustrations of the technocrat's belief that every problem necessarily has a solution, and that only the 'experts' can define and resolve the problems. It is hard to escape the conclusion that the nuclear establishment's obsession with reactor safety is a deliberate ploy, intended to exclude the citizen from the nuclear power debate and from democratic decision-making.

Von Hippel makes a token move toward putting reactor safety in a larger perspective by pointing to the waste reprocessing plant as worthy of more concern. But even then he ignores or avoids the tougher conclusion: Nuclear power is totally incompatible with human life and democracy not only because of its unique potential for unprecedented catastrophe, but because the infra- and superstructures required to sustain this massive unforgiving technology—financing, security measures, engineered safeguards, political structures and regulations, to name a few—will stress our already shaky society to the breaking point.

This unique potential for irreversible catastrophe, for effects far into the future, and its control over our economic and political institutions are prima facie arguments for a police state and corporate energy monopoly, wherein investors receive all the so-called benefits in the form of profits and the public, living and unborn, assumes all the risks.

It is my contention that the main problems with nuclear power are non-technical in essence and that the ethical, biological, social, political and economic problems inevitably associated with it make a total ban on fission power absolutely imperative. Any technology, no matter how seemingly 'beneficial' to any given number of people at any given time, that produces radioactive wastes, effluents, and plutonium is unfit to associate with human beings.

Furthermore, any technology that will require such a vast concentration of political and economic power is equally incompatible with a democratic society.

It is understandable, but no less outrageous, that the nuclear establishment—many members of which bear credentials earned in or near the Manhattan Project and other nuclear weapons projects—should be determining energy policy for this country unilaterally, in collusion with the government, the reactor vendors, and the utilities in order to protect their hard-earned jobs and status, without ever having obtained the consent of all human beings who will ever be affected in any way by nuclear power.

No nuclear scientist with a connection to nuclear power profit-making has the right to bludgeon government and citizens into accepting a death-dealing technology, a technology that puts private profit and jobs over human health and lives, a technology that on the face of it seems to represent ultimate control over nature but which actually subdues man and his social institutions to technological tyranny. All scientists having a personal stake in the development of commercial nuclear power should disqualify themselves from the nuclear power discussion and leave the field to citizens who are perfectly capable of determining what endangers them and their freedom.

Reactor safety has been used, for the most part, as a red herring to preempt public debate. There are many more possibilities for human error or technical failure or terrorism in other parts of the fuel cycle—if indeed the debate is to be limited to technical concerns. The anti-nuclear movement has wallowed far too long in the back-wash of whether the emergency core cooling system will work, whether hundreds rather than millions will die in the aftermath of a meltdown, whether terrorism can be prevented, or whether a plutonium canister will survive an air crash. We can no longer permit the pro-nuclear cadres to set the terms of argument. Reactor safety was a good issue to jolt the public, but compared to the issues of radioactive waste and terrorism it is like estimating how many angels can dance on the head of a pin.

Scientists decry the modern obsession with astrology but their own blind faith in the existence of an ultimate solution to every problem—as shown by Primack's bland assertion that the waste problem will eventually be solved—is no less irrational. Nor will they deal with the basic ethical question of whether we should continue to produce lethal wastes, toxic unto eternity, without knowing we *have* a solution. The decision to obtain two percent of our energy in barter for the human gene pool is morally indefensible and a national abdication of morality.

The American public, by broadening out the nuclear issue, will refuse to delegate its political power to a scientific

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elite, nor will it willingly place human lives under the vast network of bureaucracies, security guards, regulations, and vulnerable machines necessitated by the fission economy, any of which can easily be disabled by human failure or malevolence. If scientists insist on rationality in dealing with the nuclear power issue, we should demand the same of them. We should insist that they stop guaranteeing us perfect permanent operation of nuclear technology and perpetual containment of wastes. There is only one politically, biologically and ethically acceptable solution: total permanent abandonment of nuclear power.

Lorna Salzman
Mid-Atlantic Representative
Friends of the Earth
New York, N.Y.

The Wrong Point

Regarding the special report on Nuclear Reactor Safety (*Bulletin*, Sept. 1975), the point is not to figure out how to make nuclear energy acceptable but rather how to stop it because it is unacceptable. Unless, of course, the atomic scientists can figure out how to change the nature of radioactivity. As far as I know, no one considers this a fruitful line of inquiry.

Stuart A. Umpleby
Department of Management Science
George Washington University
Washington, D.C.

Cart Before the Horse

I have read your special report on Nuclear Reactor Safety with considerable interest and appreciation. I wonder, however, if the safety studies discussed (as well as the American Physical Society's study) are not putting the cart before the horse. They seem to be taking the reactor design as a given (either the U.S. boiling water reactor, BWR, or the U.S. pressurized water reactor, PWR) and then seeking the means to assure its safety. It might be more appropriate to design a reactor from scratch with safety explicitly in mind.

I suspect that our safety study expenditures on the present systems are rapidly reaching the size where it is no longer cost-benefit obvious to stick with the present designs, and it might be more economical to pursue alternative designs. For example, I suspect that the successful Canadian CANDU reactor, with its separation of moderating and cooling fluids and its many independent cooling channels, is far less susceptible to major loss of cooling accidents than either the BWR or PWR with the single cooling cavity. And it may be that the not yet developed homogeneous liquid fuel reactor will be even safer.

We seem to be intent upon pushing ahead to make as many reactor units as possible without first exploring alternatives, the pressure being the apparent necessity of doubling our electrical power output every generation. We will hopefully patch up the difficulties later, at considerable expense. Can you imagine the situation if we had proceeded the same way with aircraft? We would not be attempting to fly SPADs (World War I airplanes) the size of 747s.

I cannot help but think of the development of the automobile with its massive rearrangement of our society and its toll of a minimum of 50,000 lives a year. Surely we scientists should have learned to think and proceed more systematically.

Alvin M. Saperstein
Department of Physics
Wayne State University
Detroit, Mich.

Crossing the Jungle

Attempting to ensure that there is no excessive hazard in a nuclear reactor (or liquefied natural gas, LNG) accident is somewhat akin to ensuring there is no danger from dinosaurs when crossing the Brazilian jungle in order to get from one side of South America to the other. I have a prejudice that there are no dinosaurs there, and this prejudice is reinforced by discussions with paleontologists. I want to avoid unnecessary risks, however, so I try to ensure safety on two separate fronts. I do further studies in paleontology myself and subcontract to an independent paleontology consulting firm to do others, to try to evaluate the possibility that a few dinosaurs still remain in Brazil. However, the paleontologists themselves are cautious and merely tell me that the chance is less than one in a million of finding a dinosaur.

Some members of my party have read the science fiction story of the "Challenger" expedition and are influenced by it. They consider that the paleontologists have a professional bias and, although they do not disbelieve them outright, they believe that they may have underestimated the probability by a factor of 100 and that we should therefore assume that there is one chance in 10,000 of finding a dinosaur.

My opinion polls show that a chance of one in 10,000 is too great. So I endeavor to find out by other means. I send out a fleet of low flying airplanes to search for dinosaurs. When I find one, I will cage it in, and choose my route to avoid it. So far I have found several natives who tell me stories of strange beasts, but after diligent search I have found no dinosaurs. Is it safe to proceed to cross the jungle? And can I persuade my companions to join me? My consulting firm is not willing to *consider* giving me a recommendation until I have given them another large contract for R&D.

Faced with this insoluble problem, I will probably try to get to the other side of the jungle by going round in a ship and be drowned in a storm off Cape Horn.

Richard Wilson
The Physics Laboratories
Harvard University

Editor's response: Wait a minute. Aren't you forgetting that the question came up when you were already in the middle of the jungle?

The Impact of Energy

The series of articles on Nuclear Reactor Safety (*Bulletin*, Sept. 1975) is outstanding. It is encouraging that the responsible groups and agencies have moved away from the authoritarian *I Am the Public* stance taken in the past. With the lessening of polarization and partisanship, greater objectivity in decision-making will be possible.

The one shortcoming of hazard analysis of all energy systems, however, has yet to be considered. The comparative hazards of energy alternatives have so

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WE ALMOST LOST DETROIT

JOHN G. FULLER

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"Mr. Fuller's book is a **careful and thoughtful contribution to the nuclear power controversy.**" —**DR. HENRY W. KENDALL,** Union of Concerned Scientists, Cambridge, Mass.

"This book points out simply how the government has steadfastly endeavored, using tax dollars, to keep any but the most laundered information from the public." —**JOHN W. GOFMAN, M.D.,** Professor of Medical Physics, *University of California, Berkeley*

"I am much impressed by WE ALMOST LOST DETROIT. It contains valuable information that every American should know before this country embarks on a potentially dangerous course of nuclear energy." —**DR. HAROLD C. UREY,** Dept. of Chemistry, *University of California*

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far been weighed against the impact of localized catastrophe. No comparison has yet to be made with the possible deaths due to 'natural' causes, which may increase in the absence of adequate energy to maintain standards of survival and health.

The comparative life expectancies of citizens of industrial nations as opposed to agrarian nations tend to reflect the impact of energy availability to support survival and sustenance systems. An analysis of the life expectancy impact of energy alternatives, however, is of importance in terms of conservation as well as casualty counts.

Energy is important, not per se, but for its utilization in maintaining agricultural and industrial support of the quality of life of the population of a nation. Clearly, if some nations can maintain comparable standards of life expectancy, while consuming less energy, the desirability of examining the patterns of utilization is obvious.

James J. Glackin

Pasadena, Calif.

Passive Civil Defense

The long buried issue of civil defense against strategic nuclear weapons was brought up once more in the June issue of the *Bulletin.* Replying to Bernard Feld's article ("The Charade of Piecemeal Arms Limitation," January 1975), Walter Murphy and Eugene P. Wigner point to the defense policies of Sweden and Switzerland based on the concept of "Armed Neutrality" that supposedly provide them with effective protection from a nuclear attack. This is contrasted to the U.S. policy of making hostages of the civilian population that remains unprotected in a world of proliferating nuclear weapons.

Sweden and Switzerland are small countries with a policy of strict neutrality. They deploy no nuclear weapons, thus threatening no other nation. It is rational for such countries to include passive civil defense measures against nuclear attack in their defense posture. If the country has no offensive capability, such measures contribute to deterrence even if the civil defense is not very effective against all-out nuclear attack.

The situation is entirely different for large nations with an ever-growing arsenal of offensive strategic nuclear weapons that threaten the destruction of large parts of the world. Far from being neutral, these nations even refuse to renounce the first use of nuclear weapons since they are considered as means of coercion. In the great civil defense debate in the early 1960s, it was repeatedly said that under such conditions civil defense measures could stimulate the deployment of increased strategic nuclear fire power on the side of a potential opponent, thus initiating an intensified nuclear arms race.

Effective civil defense with its very high material and psychological cost can only be achieved in a world where strategic nuclear weapons are strictly limited in number and yield to a much lower level than we now have. Civil defense is futile in the long run until large nuclear arms reductions have been negotiated. Once this evasive goal of all rational men has been achieved, we will be well on our way to removing the present persistent threat of nuclear war, and civil defense will be unnecessary.

If the successful policy of armed neutrality by Sweden and Switzerland could be exported to the rest of the world, our future would be bright. It is not civil defense that is primarily involved in such a policy but rather the removal of the intent and of the capability of military aggression.

Kurt H. Hohenemser

School of Engineering and
Applied Science
Washington University
Saint Louis, Mo.

Ask Norman Mailer

It seems that the real problem in the world is human nature. It also seems that it would be most enlightening to find an answer to the question: Why do people hate?

I refer to those deadly hatreds which can be satisfied only by the extermination of the entire human race, or of part of it. At the risk of being obvious, I mention the phrase, "Better dead than Red." Few of those who repeat it have been personally injured by a communist. What goes on in such people's heads? Or, in their subconscious?

A suggestion may be constructive. It comes from re-reading Norman Mailer's great, but most unpleasant, novel *The Naked and the Dead,* particularly from his attempts to penetrate the minds of the General and of one of the sergeants. I respectfully suggest that the *Bulletin* invite Mailer and others, who have shown insight into fighting men, to try to answer the real question: Why do people *want* thermonuclear war?

J. Fred Roush

Montgomery, Ala.

ARMS CONTROL
or what?

Bernard T. Feld

In a paper entitled "The Charade of Piecemeal Arms Limitation" (*Bulletin*, January 1975), I tried to understand the reasons for the failure of the arms control approach: to analyze "why we have so far not even been able to provide the *necessary* [let alone sufficient] progress in Soviet-American nuclear arms control. Why, after almost 30 years of intensive efforts in this direction, are we nowhere? Indeed, we are even behind where we started, with numbers, types, forms, strengths, and all other destructive aspects of nuclear arms expanding almost unhindered, while the clear understanding that seemed universally to have grown out of the horrors of Hiroshima and Nagasaki—that nuclear weapons must never again be used—seems in grave danger of evaporating from human consciousness."

My analysis led me to the following conclusion: "Having devoted half a lifetime to the pursuit of what now appears to have been a will-o'-the wisp, I am forced, reluctantly but inexorably, to the conclusion that the arms control approach simply does not work in today's world—a different approach is essential if nuclear disaster is to be averted . . . If partial measures have only served to push the competition into new and more virulent directions, the only way out may be through a comprehensive approach. If it has been futile to engage the military technicians in arguments over technical details—to fight gimmicks with gimmicks—perhaps we could have more success by bringing the argument back to matters of principle, to questions of economics, of ethics, of morality and, quite simply, of survival."

Recognizing past failures is relatively easy; devising a positive program for future action is somewhat more difficult. In retrospect, the program outlined in that paper is neither especially original nor very inspiring. This, of course, is the problem with which critics of the arms control approach are confronted these days. We can quite generally agree on the goals—disarmament, both nuclear and conventional, under effective international controls; a world in which economic and social inequities, and the conflicts arising therefrom, can be resolved by concerted, peaceful international action; a world in which the huge gap between the affluence of the few and the destitution of the vast majority will be steadily narrowed and eventually eliminated by the common consent and cooperative efforts of all peoples; a world in which the fruits of science and technology will be turned to mankind's benefit and not to its degradation and destruction.

But the sad fact is that all the trends of contemporary history are in the opposite direction. In the circumstance, those of us who are either unwilling or unable to give up the struggle tend to divide into two camps: the 'graspers-at-straws' and the 'utopians.' By instinct, I belong to the first group. To me, even a small step in the right direction is better than stagnation. Action, even if it means running hard just to stand still, is preferable to losing by default. If the system is too powerful to change by a frontal attack, then working from the inside generally seems to me to be more promising, or less self-defeating, than open rebellion—"if you can't lick 'em, join 'em."

But even my congenital optimism is now worn thin by the erosion of 30 years of largely futile efforts. I am quite prepared to grant the 'utopians' their point: that the system is too heavily stacked against a piecemeal approach. The probability of accomplishing a large, meaningful step may be discouragingly small; but the product of the probability of success and the significance of the result (if achieved) is what counts for determining where we should exert our efforts. On this criterion, nuclear arms control hardly seems worthy of our continuing devotion.

If not arms control, then what? What other possibilities are there which have even the remotest prospect for success in the foreseeable future. General and Complete Disarmament, much as I subscribe to the goal and am prepared to join in efforts for its revival on the international agenda, still appears to me in the present context to lie in the 'never-never land' of the remote future. Even while working toward this goal, the situation calls for some more limited objectives, necessary steps on the way, that can represent significant signposts of progress. The need, as I see it, is for attainable proposals, both simple and to the point, that can serve as rallying-grounds for a worldwide movement.

A No-First-Use convention, in the form proposed below may have both the virtues of simplicity and directness. It, perhaps goes even too far in these directions. Nevertheless, it is based on the one historical precedent for successful arms limitation and restraint that we can draw upon, the Geneva Protocol of 17 June 1925, for the prohibition of the use of asphyxiating, poisonous or other gases, and of bacteriological methods of warfare. Drawing on the text of the Geneva Protocol, I suggest for serious consideration the following convention:

PROPOSED

International Convention for the Prohibition of the Use of Nuclear and Radiological Weapons

The undersigned, in the names of their respective Governments:

Whereas the use of nuclear and radiological weapons has been justly condemned by the general opinion of the civilized world; and

Whereas the prohibition of such use has been declared in various resolutions of the United Nations Organizations and in Treaties involving many of its members; and

To the end that this prohibition be universally accepted as a part of international Law, binding alike the conscience and the practice of nations;

Declare:

That the High Contracting Parties, so far as they are not already Parties to Treaties prohibiting such use, accept this prohibition and agree to be bound as between themselves according to the terms of this declaration.

The High Contracting Parties will exert every effort to induce other States to accede to the present Convention. Such accession will be notified to the Secretary-General of the United Nations Organization, and by the latter to all signatory and acceding Powers, and will take effect on the date of the notification by the Secretary-General of the United Nations Organization.

The present Convention, of which the English, Russian, Chinese, and French texts are all authentic, shall be ratified as soon as possible. It shall bear the date __________.

The ratifications of the present Convention shall be addressed to the Secretary-General of the United Nations Organization, who will at once notify the deposit of such ratification to each of the signatory and acceding Powers.

The instrument of ratification and of accession to the present Convention will remain deposited in the archives of the United Nations Organization.

The present Convention will come in force for each signatory Power as from the date of its ratification, and, from that moment, each Power will be bound as regards other Powers which have already deposited their ratifications.

In anticipation of the arguments—both pro and con—concerning this proposal, I have the following comments:

1. The Geneva Protocol, and the proposed Convention as well, amounts to no more than a statement of intent on the part of the signatories that they will not be the first to use such weapons. As such, it is more or less a No-First-Use agreement, which does not foreclose the use of such weapons in retaliation against their use by an 'enemy.' In particular, it can be taken to imply the legitimacy of 'retaliation in kind' against the first-use by the other side, and thus could tend to sanction the stockpiling of such weapons for use against a transgressor. Nevertheless, by virtue of the fact that the proposed Convention draws a firm, unequivocal line between the non-use and the use of such weapons, it should provide an effective 'fire-break' against their introduction in any conflict situation, just as the Geneva Protocol has succeeded in doing, with only minor exceptions, since the introduction of chemical weapons of World War I. This inhibition has worked with chemical and biological weapons even in the case of non-signatories. In view of the recent erosion of the doctrine of nuclear deterrence, the reinforcement of such an inhibition against the first-use of a nuclear weapon seems particularly important at this time.

2. The proposed Convention bears a distinct and undeniable resemblance to the 'ban-the-bomb' proposals of the immediate post-World War II period. That campaign was associated in the minds of many western intellectuals with certain aspects of Cold War propaganda. This represents a serious handicap to its universal acceptance. For this reason, as well as for the other more legitimate tactical reasons, it is *essential* that the campaign for the acceptance of the Convention should not only invoke the broadest support of intellectuals of all political colorations, but that it should be 'legitimized' at the earliest possible stage through adoption by the United Nations as an official International Convention. Hopefully, this could be introduced into the agenda of this year's session of the General Assembly, or at least in the Conference of the Committee on Disarmament (CCD).

3. The proposed Convention nevertheless is still subject to the criticism that it falls within the arms control realm and does not represent any real *disarmament.* This same argument can be applied to the Geneva Protocol. However, the latter did lead directly, albeit with a 47-year delay, to the Biological Convention of 1972 on

Bernard T. Feld named editor-in-chief

Bernard T. Feld, who helped as a young man to develop the atomic bomb and has devoted much of his adult life to efforts to control it, is the new editor-in-chief of the *Bulletin of the Atomic Scientists*. He fills the vacancy created in May 1973 by the death of Eugene Rabinowitch, who co-founded the Bulletin 30 years ago as an international forum for the discussion of nuclear policy and other urgent questions in the postwar world.

Dr. Feld, 56, is professor of physics at the Massachusetts Institute of Technology in Cambridge, specializing in the theory of the structure of elementary particles. He is concluding a term as secretary-general of the Pugwash Conferences on Science and World Affairs, the London-based organization which brings scientists together from various nations to study critical world problems.

Like Dr. Rabinowitch and others who helped establish the Bulletin, Dr. Feld participated in development of the first atomic bomb—as an assistant to Enrico Fermi and Leo Szilard—during World War II and then turned his attention to the need for effective public control over atomic energy. He lobbied for creation of the civilian Atomic Energy Commission and for international control of atomic energy. He has played a leading role in arms control and disarmament work through such organizations as Pugwash, the Council for a Livable World, the Federation of American Scientists and the American Academy of Arts and Sciences.

Last April he received the American Physical Society's 1975 Leo Szilard Award for physics in the public interest.

Dr. Feld will continue to teach at M.I.T. while serving as editor-in-chief of the Bulletin. General management of the Bulletin, which is headquartered at the University of Chicago, will continue under the direction of Samuel H. Day, Jr., who was appointed editor in January 1974.

the prohibition of the development, production and stockpiling of all bacteriological (biological) and toxin weapons and on their destruction—perhaps the most effective measure of true disarmament yet achieved. It is true enough that the prohibition and destruction of chemical weapons is still in the negotiating stage. On the other hand, chemical weapons have been rather more widely disseminated than nuclear weapons. Furthermore, the acceptance of their absolute prohibition has always been clouded by reservations on the part of some nations concerning the applicability of the Geneva Protocol to non-lethal chemical agents. But there are *no* non-lethal nuclear weapons, and any attempts to 'humanize' their consequences and/or to legitimize their use must be vigorously opposed.

4. The main argument advanced against such a general No-First-Use proposal is that political and economic developments of the last 20 years have resulted in the hopeless addiction of many countries to a dependence on the threat of nuclear war in order to deter a *conventional* attack by a potential adversary. Thus, the NATO 'trip-wire' strategy has been extended to other situations—for example, the confrontations in Korea, Berlin and in the Middle East. Short of an agreement for General and Complete Disarmament, we are told, it will be impossible to convince those who fear conventional aggression—and who are not in a material and economic position to match the conventional force potential of the other side—that they should give up this seemingly effective form of the nuclear umbrella. If this argument is really irrefutable, if the threat of nuclear war is the only available defense of the weak, then I can only respond in Mozart's immortal words of Don Giovanni's man Leparello: "Padrone, siamo tutti morti."

Nevertheless, I recognize that universal acceptance of a No-First-Use policy with regard to nuclear weapons may take some time (given the Geneva Protocol). It may be necessary to reconcile ourselves to some delay of its acceptance in certain areas of the world, pending the working out of more rational arrangements for the defense and preservation of national sovereignty. In the case of NATO, for example, a solution of the current dilemma requires an overall settlement in terms of a Mutual Force Reduction Agreement, in which the elimination of tactical nuclear forces and of the trip-wire strategy is tied to a strict limitation of conventional forces and the acceptance of mutual guarantees against both overt and covert aggression. However, the widespread adoption of the No-First-Use philosophy by those countries, who now find it in their interests to do so, could provide the other countries with the badly needed impetus to seek arrangements that will make it possible for them to base their security on less lethal alternatives. □

NOBEL LAUREATE

Andrei Sakharov, who has defended liberty in the Soviet Union at great personal sacrifice, won the 1975 Nobel Peace Prize on October 9. The citation by the Nobel committee of the Norwegian Parliament included this:

"Andrei D. Sakharov has addressed his message to all the peoples of the world. For him it is a fundamental principle that world peace can have no lasting value unless it is founded on respect for the individual human being in society."

The need for an open world

Andrei Sakharov calls on scientists to intensify the campaign for a nuclear weapons ban and full disarmament

Andrei Sakharov

The tragedy that, 30 years ago, befell Hiroshima and Nagasaki has been distressing me throughout my life both as an atomic physicist and as simply a man of Planet Earth, which could be entirely reduced to such heaps of horrible ruins if reason and goodness do not prevail over mutual distrust, fear, greed, and hatred.

None here believe, I think, that the cause of the catastrophe hanging over mankind lies in the great scientific discoveries of the twentieth century or in some demoniac qualities of human nature. We all are, on the contrary, convinced that science has now brought about the possibility of an abundance in the world which was totally unattainable a hundred years ago. We know too that man, with all his advantages and drawbacks, is still the same as in the times of Aeschylus and the Biblical prophets, no matter whether he be white, black or yellow; capitalist, worker or scientist; believer or atheist; socialist or one of those whom some call reactionary. I do not intend to analyze here the complicated reasons for the rise of the present critical world situation. I have tried to explain my point of view, subjective and arguable as it may be, in a book now appearing in the West [*On My Country and the World*]. Yet, I would like to attempt to reiterate briefly some of the thoughts contained therein which, I believe, have reference to the problems considered at this conference.

I share the view of many of those present that the problems of disarmament have an evident priority over other problems confronting mankind now; but they cannot be solved without strengthening international confidence, without overcoming the closed attitude of the socialist countries, and in isolation from other aspects of détente.

The most important aim of détente must be the total prohibition of nuclear weaponry and full disarmament. This aim can be reached only gradually. At each stage of this process it is necessary to achieve the reduction of armaments to an equal level: equal overall strength of thermonuclear military equipment of the Soviet Union and the United States to be achieved through negotiations on the limitation of strategic weapons; an equal number of tanks and divisions of NATO and the Warsaw

Andrei Sakharov, the distinguished Russian physicist and political activist, addressed a statement to the Pugwash Symposium on "New Designs for Complete Nuclear Disarmament" which was held in Kyoto, Japan, from August 28 to September 1. He could not, of course, attend in person, and so his statement was read to us by his friend Frantisek Janouch, a Czech physicist now living and working in exile in Sweden. In accordance with the rules governing the mechanics of Pugwash Symposia, Sakharov's statement will not appear in any reports or summaries of the Kyoto Symposium which may be published in the future. Therefore, believing that Sakharov's views on arms control and disarmament questions are of great interest to American and other workers in this field, we are asking the Bulletin *to make them available in full to its readers. The English translation was prepared by Janouch.*

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Pact countries, to be achieved through European disarmament negotiations; an equality of the armed forces of the Soviet Union and the Chinese People's Republic concentrated along the common frontier. The principle of a proportional limitation of armaments seems to me unjust because it gives an advantage to the stronger side.

The realization of complete international control of armaments is of fundamental importance. This is one of those questions on which the Soviet Union and the other socialist states have taken a particularly unyielding and unconstructive position. Yet it is this very question that requires the greatest urgency. It is necessary to bring about the creation of international inspection teams with the right of free access to all regions of the inspected country. There exist already some precedents of this kind. It is indispensable to get rid of, once and for all, spy mania. Notions like 'miliatry secret,' 'secret work,' or 'publication suppressed for reasons of secrecy,' should not exist in the world of the future. Obviously, the transition to such an *open world* (Niels Bohr's expression) will be gradual. One of the first steps in that direction should be the realization of clauses 13 and 19 of the General Declaration of Human Rights, that is, a free exchange of people and information on the basis of legislative acts—free travel of people from one country to another, a free choice of the country of residence (and, of course, a free choice of residence inside a country!), a free reception of broadcast and televised programs, a free international book market. All this is directly related to international trust and thus to international security.

It is very important to find solutions as quickly as possible to the particular problems of disarmament—to agree to discontinue the development of exceptionally dangerous new types of weapons, to agree on the prohibition of strategic rockets with thermonuclear, multiple independently targetable warheads, to agree on the limitation of the production of antirocket weapons and to agree on the diminution of other activities leading to strategic instability.

Of great importance for international security would be, I believe, the prohibition of arms deliveries from countries with highly developed armaments industries to developing countries, and particularly to countries where armed conflicts are either in progress or are imminent. Such a prohibition would not only have considerable humanitarian importance but would also serve to increase world stability, since it is observable that at the present time arms deliveries are one of the primary means by which the great powers are struggling to extend their spheres of influence. And, as far as the developing countries themselves are concerned, such a solution would assist peaceful economic development rather than militarization.

For many years, and with sustained attention, I have been following the work of the Pugwash conferences on the basis of the scanty data being published in the Soviet Union or obtained through unofficial channels. Unfortunately, one has the impression that the conferences are often no more than a way of unofficially sounding out government positions, and that they have little practical success in enabling the community (including the scientific community) to influence governments on matters so vital to all mankind.

I hope that further Pugwash conferences will succeed in exerting a greater influence on world public opinion, and thus on the policies of government decision-makers.

July 10, 1975 ☐

BODY PLEASURE AND THE ORIGINS OF VIOLENCE

A neuropsychologist contends that the greatest threat to world peace comes from those nations which have the most depriving environments for their children and which are most repressive of sexual affection and female sexuality

James W. Prescott

Human violence is fast becoming a global epidemic. All over the world, police face angry mobs, terrorists disrupt the Olympics, hijackers seize airplanes, and bombs wreck buildings. During the past year, wars raged in the Middle East, Cyprus, and Southeast Asia, and guerrilla fighting continued to escalate in Ireland. Meanwhile, crime in the United States grew even faster than inflation. Figures from the Federal Bureau of Investigation show that serious crimes rose 16 percent in the first six months of 1974—one of the largest crime increases since FBI record-keeping began.

Unless the causes of violence are isolated and treated, we will continue to live in a world of fear and apprehension. Unfortunately, violence is often offered as a solution to violence. Many law enforcement officials advocate 'get tough' policies as the best method to reduce crime. Imprisoning people, our usual way of dealing with crime, will not solve the problem, because the causes of violence lie in our basic values and the way in which we bring up our children and youth. Physical punishment, violent films and TV programs teach our children that physical violence is normal. But these early life experiences are not the only or even the main source of violent behavior. Recent research supports the point of view that the deprivation of physical pleasure is a major ingredient in the expression of physical violence. The common as-

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sociation of sex with violence provides a clue to understanding physical violence in terms of deprivation of physical pleasure.

Unlike violence, pleasure seems to be something the world can't get enough of. People are constantly in search of new forms of pleasure, yet most of our 'pleasure' activities appear to be substitutes for the natural sensory pleasures of touching. We touch for pleasure or for pain or we don't touch at all. Although physical pleasure and physical violence seem worlds apart, there seems to be a subtle and intimate connection between the two. Until the relationship between pleasure and violence is understood, violence will continue to escalate.

As a developmental neuropsychologist I have devoted a great deal of study to the peculiar relationship between violence and pleasure. I am now convinced that the deprivation of physical sensory pleasure is the principal root cause of violence. Laboratory experiments with animals show that pleasure and violence have a reciprocal relationship, that is, *the presence of one inhibits the other.* A raging, violent animal will abruptly calm down when electrodes stimulate the pleasure centers of its brain. Likewise, stimulating the violence centers in the brain can terminate the animal's sensual pleasure and peaceful behavior. When the brain's pleasure circuits are 'on,' the violence circuits are 'off,' and vice versa. Among human beings, a pleasure-prone personality rarely displays violence or aggressive behaviors, and a violent personality has little ability to tolerate, experience, or enjoy sensuously pleasing activities. As either violence or pleasure goes up, the other goes down.

Sensory Deprivation

The reciprocal relationship of pleasure and violence is highly significant because certain sensory experiences during the formative periods of development will create a neuropsychological predisposition for either violence-seeking or pleasure-seeking behaviors later in life. I am convinced that various abnormal social and emotional behaviors resulting from what psychologists call 'maternal-social' deprivation, that is, a lack of tender, loving care, are caused by a unique type of sensory deprivation, *somatosensory* deprivation. Derived from the Greek word for 'body,' the term refers to the sensations of touch and body movement which differ from the senses of light, hearing, smell and taste. I believe that the deprivation of body touch, contact, and movement are the basic causes of a number of emotional disturbances which include depressive and autistic behaviors, hyperactivity, sexual aberration, drug abuse, violence, and aggression.

Violence against sexuality and the use of sexuality for violence, particularly against women, has very deep roots in Biblical tradition.

These insights were derived chiefly from the controlled laboratory studies of Harry F. and Margaret K. Harlow at the University of Wisconsin. The Harlows and their students separated infant monkeys from their mothers at birth. The monkeys were raised in single cages in an animal colony room, where they could develop social relationships with the other animals through seeing, hearing, and smelling, but not through touching or movement. These and other studies indicate that it is the deprivation of body contact and body movement—not deprivation of the other senses—that produces the wide variety of abnormal emotional behaviors in these isolation-reared animals. It is well known that human infants and children who are hospitalized or institutionalized for extended periods with little physical touching and holding develop almost identical abnormal behaviors, such as rocking and head banging.

Although the pathological violence observed in isolation-reared monkeys is well documented, the linking of early somatosensory deprivation with physical violence in humans is less well established. Numerous studies of juvenile delinquents and adult criminals have shown a family background of broken homes and/or physically abusive parents. These studies have rarely mentioned, let alone measured, the degree of deprivation of physical affection, although this is often inferred from the degree of neglect and abuse. One exceptional study in this respect is that of Brandt F. Steele and C. B. Pollock, psychiatrists at the University of Colorado, who studied child abuse in three generations of families who physically abused their children. They found that parents who abused their children were invariably deprived of physical affection themselves during childhood and that their adult sex life was extremely poor. Steele noted that almost without exception the women who abused their children had never experienced orgasm. The degree of sexual pleasure experienced by the men who abused their children was not ascertained, but their sex life, in general, was unsatisfactory. The hypothesis that physical pleasure actively inhibits physical violence can be appreciated from our own sexual experiences. How many of us feel like assaulting someone after we have just experienced orgasm?

The contributions of Freud to the effects of early experiences upon later behaviors and the consequences of repressed sexuality have been well established. Unfortunately time and space do not permit a discussion here of his differences with Wilhelm Reich concerning his *Beyond the Pleasure Principle.*

The hypothesis that deprivation of physical pleasure results in physical violence requires a formal systematic evaluation. We can test this hypothesis by examining cross-cultural studies of child-rearing practices, sexual behaviors, and physical violence. We would expect to find that human societies which provide their infants and children with a great deal of physical affection (touching, holding, carrying) would be less physically violent than human societies which give very little physical affection to their infants and children. Similarly, human societies which tolerate and accept premarital and extramarital sex would be less physically violent than societies which prohibit and punish premarital and extramarital sex.

Cultural anthropologists have gathered exactly the data required to examine this hypothesis for human societies—and their findings are conveniently arranged in R. B. Textor's *A Cross-Cultural Summary* [1]. Textor's book is basically a research tool for cross-cultural statistical inquiry. The survey provides some 20,000 statistically significant correlations from 400 culture samples of primitive societies.

Infant Neglect/Adult Violence

Certain variables which reflect physical affection (such as fondling, caressing, and playing with infants) were related to other variables which measure crime and violence (frequency of theft, killing, etc.). The important relationships are displayed in the tables. The percent figures reflect the relationships among the variables, for example, high affection/low violence plus low affection/high violence. This procedure is followed for all tables.

Societies ranking high or low on the Infant Physical Affection Scale were examined for degree of violence. The results (Table 1) clearly indicated that those societies which give their infants the greatest amount of physical affection were characterized by low theft, low infant physical pain, low religious activity, and negligible or absent killing, mutilating, or torturing of the enemy. These data directly confirm that the deprivation of body pleasure during infancy is significantly linked to a high rate of crime and violence.

Some societies physically punish their infants as a matter of discipline, while others do not. We can determine whether this punishment reflects a general concern for the infant's welfare by matching it against child nurturant care. The results (Table 2) indicate that societies which inflict pain and discomfort upon their infants tend to neglect them as well. These data provide no support for the prescription from Proverbs (23: 13-14): "Withhold not chastisement from a boy; if you beat him with the rod, he will not die. Beat him with the rod, and you will save him from the nether world."

Adult physical violence was accurately predicted in 36 of 49 cultures (73 percent) from the infant physical affection variable. The probability that a 73 percent rate of accuracy could occur by chance is only four times out of a thousand.

Of the 49 societies studied, 13 cultures seemed to be exceptions to the theory that a lack of somatosensory pleasure makes people physically violent (see Table 3). It was expected that cultures which placed a high value upon physical pleasure during infancy and childhood would maintain such values into adulthood. This is not the case. Childrearing practices do not predict patterns of later sexual behavior. This initial surprise and presumed discrepancy, however, becomes advantageous for further prediction.

The Long-Term Consequences of Infant Pleasure and Pain

Human societies differ greatly in their treatment of infants. In some cultures, parents lavish physical affection on infants, while in others the parents physically punish their infants. A study of anthropological data by the author [2] found that those societies which give their infants the greatest amount of physical affection have less theft and violence among adults, thus supporting the theory that deprivation of bodily pleasure during infancy is significantly linked to a high rate of crime and violence. The tables below show how physical affection—or punishment—given infants correlates with other variables. For example, cultures which inflict pain on infants appear to be more likely to practice slavery, polygyny, etc. In the tables, *N* refers to the number of cultures in the comparison while *P* is the probability that the observed relationship could occur by chance which was calculated by the Fisher Exact Probability Test.

TABLE 1

Adult Behaviors in Societies Where Physical Affection is Lavished on Infants

Adult Behaviors	Percent %	N	Probability P
Invidious display of wealth is low	66	50	.06
Incidence of theft low	72	36	.02
Overall infant indulgence high	80	66	.0000
Infant physical pain low	65	63	.03
Negligible killing, torturing or mutilating the enemy	73	49	.004
Low religious activity	81	27	.003

TABLE 2

Adult Behaviors in Societies Where Pain is Inflicted on Infants by Parent or Nurturing Person

Adult Behaviors	Percent %	N	Probability P
Slavery is present	64	66	.03
Polygyny (multiple wives) practiced	79	34	.001
Women status inferior	78	14	.03
Low infant physical affection	65	63	.03
Low overall infant indulgence	77	66	.000
Developing nurturant behavior in child is low	67	45	.05
Supernaturals (gods) are aggressive	64	36	.01

The coded scales on infancy were developed by cultural anthropologists Barry, Bacon and Child [3]; on sexual behavior by Westbrook, Ford and Beach [4]; and on physical violence by Slater [5].

Infant Physical Affection and Adult Physical Violence

Societies that provide infants with a great deal of physical affection ('tender loving care') are later characterized by relatively non-violent adults. In 36 of the 49 cultures studied, a high degree of infant affection was associated with a low degree of adult physical violence—and vice versa. When the 13 exceptions were investigated, it was found that the violence of all but one (the Jivaro tribe of South America) could be accounted for by the presence or absence of premarital sexual behavior.

TABLE 3

Relationship of Infant Physical Affectional Deprivation to Adult Physical Violence

High Infant Physical Affection	Low Infant Physical Affection	High Infant Physical Affection	Low Infant Physical Affection
Low Adult Physical Violence	**High Adult Physical Violence**	**High Adult Physical Violence**	**Low Adult Physical Violence**
Andamanese	Alorese	Cheyenne	Ainu
Arapesh	Aranda	Chir-Apache	Ganda
Balinese	Araucanians	Crow	Kwakiutl
Chagga	Ashanti	Jivaro	Lepcha
Chenchu	Aymara	Kurtatchi	Pukapuka
Chuckchee	Azande	Zuni	Samoans
Cuna	Comanche		Tanala
Hano	Fon		
Lau	Kaska		
Lesu	Marquesans		
Maori	Masai		
Murngin	Navaho		
Nuer	Ojibwa		
Papago	Thonga		
Siriono			
Tallensi			
Tikopia			
Timbira			
Trobriand			
Wogeo			
Woleaians			
Yahgan			

Source: Textor [1]; infant behavior ratings from Barry, Bacon and Child [3]; and adult violence ratings from Slater [5].

Two variables that are highly correlated are not as useful for predicting a third variable as two variables that are uncorrelated. Consequently, it is meaningful to examine the sexual behaviors of the 13 cultures whose adult violence was not predictable from physical pleasure during infancy. Apparently, the social customs which influence and determine the behaviors of sexual affection are different from those which underlie the expression of physical affection toward infants.

When the six societies characterized by both high infant affection and high violence are compared in terms of their premarital sexual behavior, it is surprising to find that five of them exhibit premarital sexual repression, where virginity is a high value of these cultures. It appears that *the beneficial effects of infant physical affection can be negated by the repression of physical pleasure (premarital sex) later in life.*

The seven societies characterized by both low infant physical affection and low adult physical violence were all found to be characterized by permissive premarital sexual behaviors. Thus, *the detrimental effects of infant physical affectional deprivation seem to be compensated for later in life by sexual body pleasure experiences during adolescence.* These findings have led to a revision of the somatosensory pleasure deprivation theory from a one-stage to a two-stage developmental theory where the physical violence in 48 of the 49 cultures could be accurately classified.

In short, violence may stem from deprivation of somatosensory pleasure either in infancy or in adolescence. The only true exception in this culture sample is the headhunting Jivaro tribe of South America. Clearly, this society requires detailed study to determine the causes of its violence. The Jivaro belief system may play an important role, for as anthropologist Michael Harner notes in *Jivaro Souls* [6], these Indians have a "deep-seated belief that killing leads to the acquisition of souls which provide a supernatural power conferring immunity from death."

The strength of the two-stage deprivation theory of violence is most vividly illustrated when we contrast the societies showing high rates of physical affection during infancy *and* adolescence against those societies which are consistently low in physical affection for both developmental periods. The statistics associated with this relationship are extraordinary: The percent likelihood of a society being physically violent if it is physically affectionate toward its infants *and* tolerant of premarital sexual behavior is 2 percent (48/49). The probability of this relationship occurring by chance is 125,000 to one. I am not aware of any other developmental variable that has such a high degree of predictive validity. Thus, we seem to have a firmly based principle: Physically affectionate human societies are highly unlikely to be physically violent.

Accordingly, when physical affection and pleasure during adolescence as well as infancy are related to measures of violence, we find direct evidence of a significant relationship between the punishment of premarital sex behaviors and various measures of crime and violence. As Table 4 shows, additional clusters of relationships link the punishment and repression of premarital sex to large community size, high social complexity and class stratification, small extended families, purchase of wives, practice of slavery, and a high god present in human morality. The relationship between small extended families and punitive premarital sex attitudes deserves emphasis, for it suggests that the nuclear Western cultures may be a contributing factor to our repressive attitudes toward sexual expression.

The same can be suggested for community size, social complexity, and class stratification.

Not surprisingly, when high self-needs are combined with the deprivation of physical affection, the result is self-interest and high rates of narcissism. Likewise, exhibitionistic dancing and pornography may be interpreted as a substitute for normal sexual expression. Some nations which are most repressive of female sexuality have rich pornographic art forms.

Extramarital Sex

I also examined the influence of extramarital sex taboos upon crime and violence. The data clearly indicates that punitive-repressive attitudes toward extramarital sex are also linked with physical violence, personal crime, and the practice of slavery. Societies which value monogamy emphasize military glory and worship aggressive gods.

These cross-cultural data support the view of psychologists and sociologists who feel that sexual and psychological needs not being fulfilled within a marriage should be met outside of it, without destroying the primacy of the marriage relationship.

These findings overwhelmingly support the thesis that deprivation of body pleasure throughout life—but particularly during the formative periods of infancy, childhood, and adolescence—are very closely related to the amount of warfare and interpersonal violence. These insights should be applied to large and complicated industrial and postindustrial societies.

Crime and physical violence have substantially increased over the past decade in the United States. According to FBI statistics, both murder and aggravated assault increased 53 percent between 1967 and 1972, while forcible rape rose 70 percent.

These figures again raise the question of the special relationship between sexuality and violence. In addition to our rape statistics, there is other evidence that points to preference for sexual violence over sexual pleasure in the United States. This is reflected in our acceptance of sexually explicit films that involve violence and rape, and our rejection of sexually explicit films for pleasure only (pornography). Neighborhood movie theaters show such sexually violent films as *Straw Dogs, Clockwork Orange,* and *The Klansman,* while banning films which portray sexual pleasure (*Deep Throat, The Devil in Miss Jones*). Attempts to close down massage parlors are another example of our anti-pleasure attitudes. Apparently, sex with pleasure is immoral and unacceptable, but sex with violence and pain is moral and acceptable.

A questionnaire I developed to explore this question was administered to 96 college students whose average age was 19 years. The results of the questionnaire support the connection between rejection of physical pleasure (and particularly of premarital and extramarital sex) with expression of physical violence. Respondents who reject abortion, responsible premarital sex, and nudity within the family were likely to approve of harsh physical punishment for children and to believe that pain helps build strong moral character. These respondents were likely to find alcohol and drugs more satisfying than sex. The data obtained from the questionnaire provide strong statistical support for the basic inverse relationship between physical violence and physical pleasure. If violence is high, pleasure is low, and conversely, if pleasure is high, violence is low. The questionnaire bears out the theory that the pleasure-violence relationship found in primitive cultures also holds true for a modern industrial nation.

Another way of looking at the reciprocal relationship between violence and pleasure is to examine a society's choice of drugs. A society will support behaviors that are consistent with its values and social mores. U.S. society is a competitive, aggressive, and violent society. Consequently, it supports drugs that fa-

Premarital Sex, Physical Violence and Other Adult Behaviors

Premarital sexual freedom for young people can help reduce violence in a society, and the physical pleasure that youth obtains from sex can offset a lack of physical affection during infancy. Other research also indicates that societies which punish premarital sex are likely to engage in wife purchasing, to worship a high god in human morality, and to practice slavery. Other results are shown in the table below.

TABLE 4

Adult Behaviors in Societies Where Premarital Sex is Strongly Punished

Adult Behaviors	Percent %	N	Probability P
Community size is larger	73	80	.0003
Slavery is present	59	176	.005
Societal complexity is high	87	15	.01
Personal crime is high	71	28	.05
Class stratification is high	60	111	.01
High incidence of theft	68	31	.07
Small extended family	70	63	.008
Extramarital sex is punished	71	58	.005
Wives are purchased	54	114	.02
Castration anxiety is high	65	37	.009
Longer post-partum sex taboo	62	50	.03
Bellicosity is extreme	68	37	.04
Sex disability is high	83	23	.004
Killing, torturing and multilating the enemy is high	69	35	.07
Narcissism is high	66	38	.04
Exhibitionistic dancing is emphasized	65	66	.04
High god in human morality	81	27	.01

cilitate competitive, aggressive, and violent behaviors and opposes drugs that counteract such behaviors. Alcohol is well known to facilitate the expression of violent behaviors, and, although addicting and very harmful to chronic users, is acceptable to U.S. society. Marijuana, on the other hand, is an active pleasure-inducing drug which enhances the pleasure of touch and actively inhibits violent-aggressive behaviors. It is for these reasons, I believe that marijuana is rejected in U.S. society. For similar reasons heroin is rejected and methadone (an addicting drug minus the pleasure) is accepted.

The data from my questionnaire support this view. As Table 5 shows, very high correlations between alcohol use and parental punishment indicate that people who received little affection from their mothers and had physically punitive fathers are likely to become hostile and aggressive when they drink. Such people find alcohol more satisfying than sex. There is an even stronger relationship between parental physical punishment and drug usage. Respondents who were physically punished as children showed alcohol-induced hostility and aggression and were likely to find alcohol and drugs more satisfying than sex. The questionnaire also reveals high correlations between sexual repression and drug usage. Those who describe premarital sex as "not agreeable" are likely to become aggressive when drinking and to prefer drugs and alcohol to sexual pleasures. This is additional evidence for the hypothesis that drug 'pleasures' are a substitute for somatosensory pleasures.

Religious Roots

The origins of the fundamental reciprocal relationship between physical violence and physical pleasure can be traced to philosophical dualism and to the theology of body/soul relationships. In Western philosophical thought man was not a unitary being but was divided into two parts, body and soul. The Greek philosophical conception of the relationship between body and soul was quite different than the Judeo-Christian concept which posited a state of war between the body and soul. Within Judeo-Christian thought the purpose of human life was to save the soul, and the body was seen as an impediment to achieving this objective. Consequently, the body must be punished and deprived. In St. Paul's words: "Put to death the base pursuits of the body—for if you live according to the flesh, you shall die: but if by the spirit you mortify the deeds of the flesh, you shall live" (Romans 9:13). St. Paul clearly advocated somatosensory pleasure deprivation and enhancement of painful somatosen-

Violence and Pleasure: The Attitudes of College Students

The reciprocal relationship of violence and pleasure holds true in modern industrial nations as well as primitive societies. This theory was tested by means of a questionnaire given to 96 college students (average age: 19). The results showed that students who have relatively negative attitudes toward sexual pleasure tend to favor harsh punishment for children and to believe that violence is necessary to solve problems. The students rated a series of statements on a scale of 1 to 6, where 1 indicated strong agreement and 6 strong disagreement. Through a statistical technique (factor analysis), a personality profile of the violent person was developed. Table 5 shows the degree of relationship among the various statements which reflect social and moral values. The figures at left, known as 'loadings,' are treated like correlation coefficients. They indicate the strength with which each variable contributes to the overall personality description of the respondent as defined by this specific profile.

TABLE 5

Somatosensory Index of Human Affection
Factor 1:66.6%

Violence Approved

.85	Hard physical punishment is good for children who disobey a lot.
.81	Physical punishment and pain help build a strong moral character.
.76	Capital punishment should be permitted by society.
.75	Violence is necessary to really solve our problems.
.74	Physical punishment should be allowed in the schools.
.69	I enjoy sadistic pornography.
.54	I often feel like hitting someone.
.43	I can tolerate pain very well.

Physical Pleasure Condemned

.84	Prostitution should be punished by society.
.80	Abortion should be punished by society.
.80	Responsible premarital sex is not agreeable to me.
.78	Nudity within the family has a harmful influence upon children.
.73	Sexual pleasures help build a weak moral character.
.72	Society should interfere with private sexual behavior between adults.
.69	Responsible extramural sex is not agreeable to me.
.61	Natural fresh body odors are often offensive.
.47	I do not enjoy affectional pornography.

Alcohol and Drugs Rated Higher than Sex

.70	Alcohol is more satisfying than sex.
.65	Drugs are more satisfying than sex.
.60	I get hostile and aggressive when I drink alcohol.
.49	I would rather drink alcohol than smoke marijuana.
.45	I drink alcohol more often than I experience orgasm.

Political Conservatism

.82	I tend to be conservative in my political points of view.
.77	Age (Older).
.51	I often dream of either floating, flying, falling, or climbing.
.45	My mother is often indifferent toward me.
.42	I often get "uptight" about being touched.
.40	I remember when my father physically punished me a lot.

The collaboration of Douglas Wallace, Human Sexuality Program, University of California Medical School, San Francisco, in the questionnaire study is gratefully acknowledged.

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sory stimulation as essential prerequisites for saving the soul.

"Now concerning the things whereof you wrote to me: *It is good for a man not to touch a woman*" (1 Corinthians, 7:1).

Aristotle did not view a state of war between the body and soul, but rather envisioned a complimentary relationship in which the state of the soul or mind was dependent on the state of the body. In fact he stated that "the care of the body ought to precede that of the soul." (*Politica*)

It is clear that the world has only limited time to change its custom of resolving conflicts violently. It is uncertain whether we have the time to undo the damage done by countless previous generations, nor do we know how many future generations it will take to transform our psychobiology of violence into one of peace.

Aristotle also appreciated the reciprocal relationship between pleasure and pain, and recognized that a compulsive search for bodily pleasure originates from a state of bodily discomfort and pain:

> Now, excess is possible in the case of the goods of the body, and it is the pursuit of excess, but not the pursuit of necessary pleasures, that makes a man bad. For all men get some kind of enjoyment from good food, wine, and sexual relations, but not everyone enjoys these things in the proper way. The reverse is true of pain: a bad person does not avoid an excess of it, but he avoids it altogether. For the opposite of an excess is pain only for the man who pursues the excess. . . .
>
> Accordingly, we must now explain why the pleasures of the body appear to be more desirable. The first reason, then, is that pleasure drives out pain. When men experience an excess of pain, they pursue excessive pleasure and bodily pleasure in general, in the belief that it will remedy the pain. These remedial (pleasures) become very intense—and that is the very reason why they are pursued because they are experienced in contrast with their opposite. (*Nichomachean Ethics*, Book 7)

In his discussion of the highest good, Aristotle was quite explicit: "Therefore, the highest good is some sort of pleasure, despite the fact that most pleasures are bad, and, if you like, bad in the unqualified sense of the word." (*Nichomachean Ethics*, Book 7)

It is evident that the Judeo-Christian concept of body pleasure is quite the opposite of that outlined by Aristotle, particularly, the relief of body pain and discomfort through somatosensory pleasure. This denial of somatosensory pleasure in Pauline Christian doctrine has led to alternative forms of 'relief' through such painful stimulations as hair-shirts, self-scourgings, self-mutilations, physical violence against others, and in the non-sensory pleasures of drugs.

Experimental animal studies have documented counterparts to these phenomena. For example, animals deprived of somatosensory stimulation will engage in mutilations of their own bodies. Animals deprived of touching early in life develop impaired pain perception and an aversion to being touched by others. They are thus blocked from experiencing the body-pleasure therapy that they need for rehabilitation. In this condition, they have few alternatives but physical violence, where pain-oriented touching and body contact is facilitated by their impaired ability to experience pain. Thus, physical violence and physical pain become therapies of choice for those deprived of physical pleasure.

The question arises as to how Christian philosophy and theology, which borrowed heavily from Aristotle, managed to avoid, if not outright reject, Aristotle's teachings regarding the morality of pleasure. The roots to this question can be found throughout the Old Testament, beginning with the account in Genesis of the expulsion of Adam and Eve from the Garden of Eden. The first consequence of Eve's transgression was that nudity became shameful. This even may well be the beginning of man's hostility toward women and the equating of woman with evil, particularly the evils of the body. This is vividly portrayed in Zechariah (5:5-8) in an angel's description of the flying bushel:

> "This is a bushel container coming. This is their guilt in all the land." Then a leaden cover was lifted and there was a woman sitting inside the bushel. "This is wickedness, he said, and he thrust her inside the bushel, pushing the leaden cover into the opening."

Violence against sexuality and the use of sexuality for violence, particularly against women, has very deep roots in Biblical tradition, and is spelled out very early. The nineteenth chapter of Genesis (19:1-11), the first book of the Old Testament, holds that the rape of woman is acceptable but the rape of man is "a wicked thing." This chapter about the destruction of Sodom and Gomorrah describes Lot's hospitality to two male travelers (actually two angels) who were housed with him.

In the evening the townsmen of Sodom came to Lot's house and said to him: "Where are the men who came to your house tonight? Bring them out to us that we may have intimacies with them." Lot went out to meet them at the entrance. When he had shut the door behind him, he said, "I beg you, my brothers, not to do this wicked thing. I have two daughters who have never had intercourse with men. Let me bring them out to you, and you may do to them as you please. But don't do anything to these men, for you know they have come under the shelter of my roof." They replied, "Stand back! This fellow," they sneered, "came here as an immigrant, and now he dares to give orders! We'll treat you worse than them!" With that, they pressed hard against Lot, moving in closer to break down the door. But his guests put out their hand, pulled Lot inside with them, and closed the door; at the same time they struck the men at the entrance of the house, one and all, with such blinding light that they were utterly unable to reach the doorway.

As the story continues, the two angels escort Lot and his family to safety and then destroy Sodom and Gomorrah for their great sinfulness. Yet not a word of reproach is given to Lot for his willingness to hand over his two virgin daughters to be gang raped. This same story is repeated in the books of Ezekiel (23:1-49) and Judges (19:22-30).

Given such a tradition, it is understandable that during the Inquisition only women were charged with having intercourse with the devil and put to death for this crime of pleasure. What man has died at the stake for having slept with Satan? This tradition is maintained in modern cultures where women are punished for prostitution but their male customers are not.

The historical and Biblical acceptance of rape down through the ages has brutalized the psyche of males brought up in this tradition. This is well illustrated in the account of Michael McCusker, a Marine sergeant who witnessed a gang rape in Vietnam. McCusker [7] tells of a rifle squad of nine men who entered a small village.

> They were supposed to go after what they called a Viet Cong whore. They went into her village and instead of capturing her, they raped her—every man raped her. As a matter of fact, one man said to me later that it was the first time he had ever made love to a woman with his boots on. The man who led the platoon, or the squad, was actually a private. The squad leader was a sergeant but he was a useless person and he let the private take over his squad. Later he said he took no part in the raid. It was against his morals. So instead of telling his squad not to do it, because they wouldn't listen to him anyway, the sergeant went into another side of the village and just sat and stared bleakly at the ground, feeling sorry for himself. But at any rate, they raped the girl, and then, the last man to make love to her, shot her in the head.

The first months. Breast-feeding and caressing will help this infant to grow into a non-violent adult. Denial of such body contact in infancy can have the opposite effect.

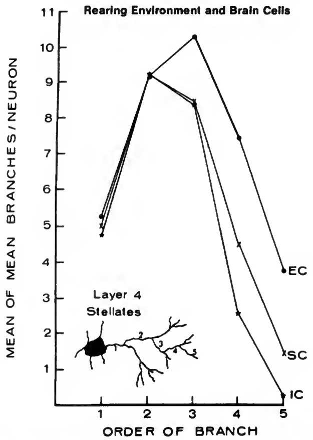
What is it in the American psyche that permits the use of the word 'love' to describe rape? And where the act of love is completed with a bullet in the head!

Why do men rape women? Researchers report that most rapists have a family background of paternal punishment and hostility and loss of maternal affection. I interpret rape as man's revenge against woman for the early loss of physical affection. A man can express his hostility toward his mother for not giving him enough physical attention by sexually violating another woman.

Another explanation may be that the increasing sexual freedom of women is threatening to man's position of power and dominance over women which he often maintains through sexual aggression. Rape destroys sensual pleasure in woman and enhances sadistic pleasure in man. Through rape, man defends himself from the sensual pleasures of women which threaten his position of power and dominance.

It is my belief that rape has its

Realistic dolls. Swedish paper doll exemplifies the frankness about the human body that is needed to inculcate wholesome attitudes toward sex and violence. In this paper doll, no attempt is made to idealize or de-sexualize the human body; the body is simply accepted as it is.



This figure shows the effects of the rearing environment upon a type of nerve cell (called a stellate) which is found in the fourth layer of a rat's visual cortex. The number of branches of the dendrites is much greater in animals reared in groups in a toy-filled environment (called enriched environmental condition, EC) than the number which occurs when two rats are reared together in an ordinary cage (called social condition, SC) or when rats are reared alone in ordinary cages (called isolate condition, IC).

These data show that extreme conditions of sensory/social deprivation are not necessary to alter brain structure, and that an enriched sensory/social environment can increase the complexity of brain cells. Dendrites, which are usually branched like a tree, are the part of the nerve cell (neuron) which carries the nerve impulse to the cell body; and they are the means by which brain cells communicate with one another. Brain cells with many dendrites can influence and regulate the activity of other brain cells more effectively than brain cells with fewer or abnormal dendrites. It is believed that the complexity of brain cells is related to the ability to solve complex problems both of an intellectual and social nature, and that abnormal dendritic structures underlie abnormal electrical 'spike' discharges in the brain.

Source: Volkmar and Greenough [9].

origins in the deprivation of physical affection in parent-child relationships and adult sexual relationships; and in a religious value system that considers pain and body deprivation moral and physical pleasure immoral. Rape maintains man's dominance over woman and supports the perpetuation of patriarchal values in our society.

It is clear that the world has only limited time to change its custom of resolving conflicts violently. It is uncertain whether we have the time to undo the damage done by countless previous generations, nor do we know how many future generations it will take to transform our psychobiology of violence into one of peace.

If we accept the theory that the lack of sufficient somatosensory pleasure is a principal cause of violence, we can work toward promoting pleasure and encouraging affectionate interpersonal relationships as a means of combatting aggression. We should give high priority to body pleasure in the context of meaningful human relationships. Such body pleasure is very different from promiscuity, which reflects a basic inability to experience pleasure. If a sexual relationship is not pleasurable, the individual looks for another partner. A continuing failure to find sexual satisfaction leads to a continuing search for new partners, that is, to promiscuous behavior. Affectionately shared physical pleasure, on the other hand, tends to stabilize a relationship and eliminate the search. However, a variety of sexual experiences seems to be normal in cultures which permit its expression, and this may be important for optimizing pleasure and affection in sexual relationships.

Available data clearly indicate that the rigid values of monogamy, chastity, and virginity help produce physical violence. The denial of female sexuality must give way to an acceptance and respect for it, and men must share with women the responsibility for giving affection and care to infants and children. As the father assumes a more equal role with the mother in child-rearing and becomes more affectionate toward his children, certain changes must follow in our socioeconomic system. A corporate structure which tends to separate either parent from the family by travel, extended meetings, or overtime work weakens the parent-child relationship and harms family stability. To develop a peaceful society, we must put more emphasis on human relationships.

Family planning is essential. Children must be properly spaced so that each can receive optimal affection and care. The needs of the infant should be immediately met. Cross-cultural evidence does not support the view that such practices will 'spoil' the infant. Contrary to Dr. Benjamin Spock, it is harmful for a baby to cry itself to sleep. By not answering an infant's needs immediately and consistently we not only teach a child distrust at a very basic emotional level, but also establish patterns of neglect which harm the child's social and emotional health. The discouragement of breast feeding in favor of bottle feeding and the separation of healthy newborns from their mothers in our 'modern' hospitals are other examples of harmful child-rearing practices.

About 25 percent of marriages in the United States now end in divorce, and an even higher percentage of couples have experienced extramarital affairs. This suggests that something is basically wrong with the traditional concept of universal monogamy. When viewed in connection with the cross-cultural evidence of the physical deprivations, violence, and warfare associated with monogamy, the need to create a more pluralistic system of marriage becomes clear. Contemporary experiments with communal living and group marriage are attempting to meet basic needs that remain unfulfilled in the isolation of a nuclear marriage. We must seriously consider new options, such as extended families comprised of two or three couples who share values and lifestyles. By sharing the benefits and responsibilities of child rearing, such families could provide an affectionate and varied environment for children as well as adults, and thereby reduce the incidence of child abuse and runaways.

The communal family—like the extended family group—can provide a more stimulating and supportive environment for both children and adults than can the average nuclear family. Communal living should not, of course, be equated with group sex, which is not a sharing, but more often an escape from intimacy and emotional vulnerability.

Openness About the Body

No matter what type of family structure is chosen, it will be important to encourage openness about the body and its functions. From this standpoint, we could benefit from redesigning our homes along the Japanese format, separating the toilet from the bathing facilities. The family bath should be used for socialization and relaxation, and should provide a natural situation for children to learn about male-female differences. Nudity, like sex, can be misused and abused, and this fear often prevents us from accepting the honesty of our own bodies.

The beneficial stimulation of whirlpool baths should not be limited to hospitals or health club spas, but brought into the home. The family bath should be large enough to accommodate parents and children, and be equipped with a whirlpool to maximize relaxation and pleasure. Nudity, openness, and affection within the family can teach children and adults that the body is not shameful and inferior, but rather is a source of beauty and sensuality through which we emotionally relate to one another. Physical affection involving touching, holding, and caressing should not be equated with sexual stimulation, which is a special type of physical affection.

The competitive ethic, which teaches children that they must advance at the expense of others, should be replaced by values of cooperation.

To Love, not Compete

The competitive ethic, which teaches children that they must advance at the expense of others, should be replaced by values of cooperation and a pursuit of excellence for its own sake. We must raise children to be emotionally capable of giving love and affection, rather than to exploit others. We should recognize that sexuality in teenagers is not only natural, but desirable, and accept premarital sexuality as a positive moral good. Parents should help teenagers realize their own sexual selfhood by allowing them to use the family home for sexual fulfillment. Such honesty would encourage a more mature attitude toward sexual relationships and provide a private supportive environment that is far better for their development than the back seat of a car or other undesirable locations outside the home. Early sexual experiences are too often an attempt to prove one's adulthood and maleness or femaleness rather than a joyful sharing of affection and pleasure.

Above all, male sexuality must recognize the equality of female sexuality. The traditional right of men to multiple sexual relationships must be extended to women. The great barrier between man and woman is man's fear of the depth and intensity of female sensuality. Because power and aggression are neutralized through sensual pleasure, man's primary defense against a loss of dominance has been the historic denial, repression, and control of the sensual pleasure of women. The use of sex to provide mere release from physiological tension (apparent pleasure) should not be confused with a state of sensual pleasure which is incompatible with dominance, power, aggression, violence, and pain. It is through the mutual sharing of sensual pleasure that sexual equality between women and men will be realized.

The sensory environment in which an individual grows up has a major influence upon the development and functional organization of the brain. Sensory stimulation is a nutrient that the brain must have to develop and function normally. How the brain functions determines how a person behaves. At birth a human brain is extremely immature and new brain cells develop up to the age of two years. The complexity of brain cell development continues up to about 16 years of age. Herman Epstein of Brandeis University has evidence that growth spurts in the human brain occur at approximately 3, 7, 11, and 15 years of age. How early deprivations affect these growth spurts has yet to be determined; however, some data suggest that the final growth spurt may be abolished by early deprivation.

W. T. Greenough, a psychologist at the University of Illinois, has demonstrated that an enriched sensory environment produces a more complex brain cell in rats than an ordinary or impoverished sensory environment (see figure). His studies show that extreme sensory deprivation is not necessary to induce structural changes in the developing brain. Many other investigators have shown that rearing rats in isolation after they are weaned induces significant changes in the biochemistry of their brain cell functioning. Other investigators have shown abnormal electrical activity of brain cell functioning in monkeys reared in isolation. I have suggested that the cerebellum, a brain structure involved in the regulation of many brain processes, is rendered dysfunctional when an animal is reared in isolation and is implicated in violent-aggressive behaviors due to somatosensory deprivation. It has been shown that cerebellar neurosurgery can change the aggressive behaviors of isolation-reared monkeys to peaceful behavior. Predatory killing behavior in ordinary house cats can be provoked by stimulating the cerebellar fastigial nucleus, one of the deep brain nuclei of the cerebellum.

Abnormally low levels of platelet serotonin have been found in monkeys reared in isolation and also in institutionalized, highly aggressive children. These findings suggest that somatosensory deprivation during the formative periods of development significantly alters an important biochemical system in the body associated with highly aggressive behaviors. A number of other investigators have documented abnormalities in the adrenal cortical response system in rodents who were isolation-reared and who developed hyperactive, hyperreactive, and hyperaggressive behavior. Thus another important biochemical system associated with aggressiveness is known to be altered by somatosensory deprivation early in life.

It needs to be emphasized here that I advocate somatosensory pleasure stimulation as a therapeutic procedure to correct the abnormalities due to somatosensory pleasure deprivation. Such sensory stimulation can influence brain functioning and it does not appear necessary, except in *rare* circumstances, that brain surgery or electrical stimulation of the brain is required to alter pathological, violent behaviors. Unfortunately, therapeutic programs of somatosensory pleasure have yet to be established to determine the effectiveness of this therapy at the human level. The success of somatosensory therapy in isolation reared monkeys reported by Harry F. Harlow and Stephen Suomi [8] when other forms of therapy have failed in these animals, provide further encouragement and support for the utilization of touch and body movement therapies in the treatment of emotional disorders.

On the contrary, our prisons have been designed to maximize those conditions that are responsible for the violence and imprisonment of the social offender. It is not surprising that physical violence in such prison environments is a major problem. The acceptance of somatosensory pleasure as a form of somatic therapy will be difficult for our society to accept, as the opposition to massage parlors in many communities indicates.

Clearly, if we consider violent and aggressive behaviors undesirable then we must provide an enriched somatosensory environment so that the brain can develop and function in a way that results in pleasurable and peaceful behaviors. The solution to physical violence is physical pleasure experienced within the context of meaningful human relationships.

For many people, a fundamental moral principle is the rejection of creeds, policies, and behaviors that inflict pain, suffering and deprivation upon our fellow humans. This principle needs to be extended: We should seek not just an absence of pain and suffering, but also the enhancement of pleasure, the promotion of affectionate human relationships, and the enrichment of human experience.

If we strive to increase the pleasure in our lives this will also affect the ways we express aggression and hostility. The reciprocal relationship between pleasure and violence is such that one inhibits the other; when physical pleasure is high, physical violence is low. When violence is high, pleasure is low. This basic premise of the somatosensory pleasure deprivation theory provides us with the tools necessary to fashion a world of peaceful, affectionate, cooperative individuals.

The world, however, has limited time to correct the conditions that propel us to violent confrontations. Modern technologies of warfare have made it possible for an individual or nation to bring total destruction to large segments of our population. And the greatest threat comes from those nations which have the most depriving environments for their children and which are most repressive of sexual affection and female sexuality. We will have the most to fear when these nations acquire the weapons of modern warfare. Tragically, this has already begun.

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H. C. Dudley

The ultimate catastrophe

It's time someone ran a computer calculation on the chances of a high order fusion explosion inducing a runaway chain reaction

In the many excellent historical and autobiographical papers which have appeared in the *Bulletin* during the past two years, little or no mention is made of the nervous strain under which the personnel of the Manhattan Project labored during the years 1941-45. Time has apparently dimmed such memories. Compare the equanimity of those in high places who now consider plans for detonating 100,000 fusion devices *annually* for alleviating the growing energy crisis.[1]

During World War II the eminent scientists of that era offered two options to President Roosevelt: accept the possible slavery of the Nazis or develop and explode atomic bombs. There was a third option, however, that was kept under wraps, *top secret*, discussed only behind closed doors, though sometimes guardedly by the lower echelons of *the* Project. This was the possibility of triggering a vast nuclear accident when and if a fission device was detonated.

The tension under which the leaders of the project were working during the developmental period was discussed by the writer Pearl Buck in

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After studying rats for 30 years I realize why people are so horrified by them. They're the animal species that comes closest to duplicating human social behavior.

an interview with Arthur H. Compton published in 1959:[2]

> "And if hydrogen, what about the hydrogen in seawater? Might not the explosion of the atomic bomb set off an explosion of the ocean itself? Nor was this all that Oppenheimer feared. The nitrogen in the air is also unstable, though less in degree. Might not it, too, be set off by an atomic explosion in the atmosphere?"
>
> "The earth would be vaporized," I said.
>
> "Exactly," Compton said, and with what gravity! "It would be the ultimate catastrophe. Better to accept the slavery of the Nazis than to run the chance of drawing the final curtain on mankind!"
>
> Again Compton took the lead in the final decision. If, after calculation, he said, it were proved that the chances were more than approximately three to one million that the earth would be vaporized by the atomic explosion, he would not proceed with the project. Calculation proved the figures *slightly* less—and the project continued.

The first trial of a high order fission explosion, the first atomic bomb (code name "Fat Man"), was set for Monday morning, July 16, 1945, 5:30 am at the Trinity site in New Mexico. The mental state that morning of those who had made the calculations of the probability of the 'ultimate catastrophe' was described as follows by Stephane Groueff some 22 years later:[3]

> On arrival [Lt. General Leslie] Groves immediately sensed the tremendous excitement in the air. Everyone was overtired, and tension was mounting visibly as zero hour approached. Groves was particularly worried about Oppenheimer, who seemed to be reaching the limit of his endurance. Groves wanted the laboratory's director to be as calm as possible when making the final command decisions. There were altogether too many excited people around giving him advice on what he should do. Groves was annoyed, too, with Fermi, who was making bets with his colleagues on whether the bomb would ignite the atmosphere, and, if so, whether it would destroy only New Mexico—or the entire world. Fermi was also saying that, even if the bomb failed to go off, it would still be a worthwhile experience—it would prove, in that case, that an atomic explosion was probably impossible.

So the Fat Man bomb was successfully detonated at Trinity, two more over Japan (1956) and two at Bikini (one under water) (1946). Between 1948 and 1958 there were about 50 more fission and fusion devices exploded in the far reaches of the Pacific. Several other nations have developed and tested these devices, thus, notifying the world of their nuclear capabilities. Isn't this sufficient evidence that such a vast nuclear accident can not occur? NO!

In 1945 the probability of such an accident was calculated to be about three in a million. This simply means that the chances of such a holocaust occurring are not numerous, but certainly *not* zero. And by the well-established principles of statistics and probability each detonation is a fresh new event, not predictable from a few previous rolls of the dice.

One may drive an automobile for years and never have so much as a scratched fender. But the likelihood of a serious accident can be measured by the ever increasing auto insurance premiums. That such events do occur all too frequently is well documented in the junkyards that are scattered on the outskirts of our cities. There we can see the workings of probability—possibilities becoming reality.

The knowledge that nuclear explosions have the potential of triggering a vast nuclear accident has been in the hands of scientists for more than 30 years. It is not known to this writer whether Presidents Roosevelt and Truman were made aware of these calculations. Nor is it known from any published material whether those who were instrumental in developing fusion devices (1948 to 1958) ever seriously considered the ultimate potential or the unexpected results of fusion explosions that were a 1,000 times as powerful as the fission device of 1945. In any case, they were all rolling dice for high stakes and the rest of us did not even know that we were sitting in the game.

The criteria in 1945 for assessing the danger of an 'ultimate catastrophe' being triggered by an atomic explosion consisted of (1) the laboratory data on fission available since 1939; (2) the theoretical assumptions and concepts developed since about 1905; and (3) the assumptions of the applicability of the mathematical systems used in developing the basic theories from which the safety projections were made.

As a result of the success of the Manhattan Project and other wartime technological developments, major governments of the world and industry have poured about 3 percent of their Gross National Product into all types of research and development. These vast expenditures have generated what is well-called the 'information explosion.' Over the last 30 years new laboratory information on the interactions of the atom have become available, new theoretical concepts are developing. The old order changeth. These studies show that fission and fusion can be triggered by lasers; that the rate of radioactive decay can easily be altered; that half-lives once thought to be constant are easily varied; and that the energy yields of fusion devices are not accurately predictable.

The theoretical foundations of the whole of nuclear science are being questioned as the result of reexamining a concept that was taught as basic in all physics textbooks pre-1920: the necessity of the presence of an all-pervading gas-like medium

Taking up where Bethe left off

In 1939 Hans Bethe published a theory that explained the source of the Sun's energy. He worked out a six-step process, a possible way, by which four ordinary hydrogen atoms (H^1) could be converted to form one helium atom (He^4). If four hydrogen atoms fuse together, they liberate large amounts of energy—conversion of mass to energy—since the mass of four H^1 atoms is greater than the mass of one He^4 atom. Inasmuch as the Sun consists largely of hydrogen, it is able to generate energy at a high rate. Bethe received the Nobel Prize in 1967 for his contribution to the theory of nuclear reactors, and especially his discoveries concerning the reactions which supply energy in the stars.

One of Bethe's six steps required the presence of the same kind of nitrogen atoms that make up 80 percent of the Earth's atmosphere:

$$N^{14} + H^1 = O^{15} + \text{energy} \qquad (1)$$

For such a reaction to start, the temperature in the interior of the Sun must be about 100 million degrees. For such a reaction to continue, the energy released must be retained near the site of its production, with containment pressure measured in tons per square inch. These are the conditions which exist in the interior of the Sun. According to Bethe, other reactions are

$$H^1 + H^1 = H^2 \text{ (deuterium, D)} + \text{energy}, \qquad (2)$$

$$D + D = He^3 + \text{neutron} + \text{energy}, \qquad (3)$$

$$D + D = H^3 + H^1 + \text{energy}, \qquad (4)$$

with reactions (3) and (4) being more probable under the conditions of containment and high temperature.

A probable secondary reaction following the formation of hydrogen by reaction (4) is

$$H^3 + D = He^4 + \text{neutron} + \text{a large energy yield}. \qquad (5)$$

Reaction (5) produces more than four times the energy per atom as do reactions (3) and (4), with a much higher probability of occurrence of (5), once the H^3 is formed by reaction (4). Under the conditions of a hydrogen-rich mixture, containing some nitrogen and deuterium, it seems logical to predict that reaction (5) may provide the means of sustaining a chain reaction as a result of the high energy yield being contained by a high pressure environment.

As indicated, the interior of the sun provides the required hydrogen-rich high pressure-high temperature environment necessary for all five of these reactions to continue for billions of years. The seas also provide a hydrogen-rich environment, with containment pressure measured in tons per square inch under millions of square miles of water. The explosion of a conventional fission or fusion device would provide the 100 million degree temperature necessary to initiate reactions (1) through (5).

Another theoretical approach is through the examination of "nuclear binding energy," which is a measure of the energy stored within the nucleus of an atom. By plotting the binding energy against the mass of the atoms one generates a curve which has marked discontinuities at that section where the lighter elements lie (hydrogen, helium, boron, beryllium, lithium). From these data one can predict that such reactions as (2) through (5) will take place. Extending this, one finds that in the segment of the curve at N^{14} and O^{16}, constituents of our atmosphere, there is another break in the curve. This is not so marked a break as lower down with the lighter elements, still it is sufficient to explain the N^{14} reaction in Bethe's solar sequence. Thus, one can conclude that both N^{14} and O^{16} may be caused to undergo fusion with the hydrogen in atmospheric moisture. The probability of a sustained chain reaction in the atmosphere does not appear as great as in the sea since there is no high pressure containment mechanism. However, as Fermi, Oppenheimer, Compton and others calculated, this probability is by no means zero.

To add weight to the above comments, it is necessary to have experimental data. But nuclear explosion research is of course classified *top secret*, since this is definitely an area of weapons research.

There is, however, some published data on those reactions that offer the greatest promise for electric power generation through fusion, namely, reactions (4) and (5) shown above.* Using this information—following in the footsteps of Bethe since he too had little data to go on in 1939—we should for safety's sake apply the information available in 1975.—H.C.D.

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*S. Glasstone and R. H. Loveberg, *Controlled Thermonuclear Reactions* (Princeton, N.J.: Van Nostrand, 1960), and D. J. Rose and M. Clark, Jr., *Plasma and Controlled Fusion* (New York: Wiley, 1961).

called 'ether' or 'aether,' which fills all space. The calculations of 1945 assumed that the ether does not exist, yet in 1975 astronomy and cosmology are beginning to define this earlier ether as the 'neutrino sea,' an energy-rich subquantic, particulate medium which fills all interstellar space. In fact, it now appears that there is more unseen mass between the stars than there is present in all the stars and their planets.

Another result of the vast expenditure of R&D funds over the past three decades has been the development of weapons and their delivery systems that stagger the imagination. Men have literally found the way in 30 short years to send a few survivors back to the caves. Given the present nuclear overkill capability both of the United States and Soviet Union, we can cause our culture to follow the route of the Mayans and Aztecs. Yet, the world's leaders, and the people too, accept this state of affairs with equanimity.

These weapons systems include intercontinental ballistic missiles with an accuracy of ±1 mile and satellites armed with multiple warheads that can spew out H-bombs like confetti. Submarines are on the prowl, each armed with H-torpedoes and long-range H-rockets. Similarly armed SAC planes are flying constant patrol. And what is the probability of some *accidental* goof-up that will cause a high order fusion detonation in seawater? Note what Compton had to say about Oppenheimer's concern in 1945 with the probabilities of a *fission* device inducing a chain reaction in the sea, not forgetting that the Earth's surface is about 85 percent water. Remember, too, that there is plenty of hydrogen and oxygen down there, along with some nitrogen, even deuterium to act as the trigger. The obvious question: What is the probability of a *fusion* device initiating a sustained chain reaction in seawater?

Because of the complexity of modern warfare, there is among the rank and file of the U.S. military a spoof on this called Murphy's Law: "If any thing can go wrong, it will." And proof of the validity of this Law is the U.S. submarine at the bottom of the South Atlantic, crew long dead, but H-bomb rocket heads intact. A Soviet sub met the same fate more recently in the mid-Pacific. Same results. A cruising SAC plane, off the coast of Spain a few year ago dropped or jettisoned its H-bomb as it made ready for a crash landing. Fortunately, the bombs did not detonate, but the fissionable material was scattered over the landscape.

Proponents of fission power visualize the near-exponential increase in the number of fission power reactors to alleviate the coming energy shortage. Others study the 'China syndrome.'* They are asking such questions as:

- Can a uranium or plutonium reactor, going supercritical, melt down to a seething white hot mass? Then what?
- Under what conditions will such an accident generate a self-sustaining metallic fire ball which will melt its way to the center of the Earth, or perhaps entirely through the Earth?

Will someone please use modern computer techniques to repeat the calculations of Oppenheimer, Compton and Fermi as to the probability of a vast nuclear accident being initiated by fission explosions. Then revise the computer program by plugging in the 1,000 times greater energy yields often derived from 1975 fusion devices.

Reprogram the problem in order to include the parameters of a high order fusion explosion inducing a sustained chain reaction in the presence of seawater, at a containment pressure of 5 tons per square inch at a depth of 4 miles. Repeat the program using pressures at 1, 2, and 3 miles depth.

In view of the information explosion, 1945-1975, generating a scientific revolution of unprecedented proportions, can we afford the luxury of waiting a generation or two before this new information seeps into our textbooks of physics, or is fed into our computer banks and, *then*, incorporated in the estimates of the State of the Union Message?

What's this simple declarative sentence doing on page 39 of your report?

Notes

1. William D. Metz, "Energy: Washington Gets a New Proposal for Using H-Bombs," *Science*, 188:4184 (April 11, 1975), 136.
2. Pearl Buck, "The Bomb—The End of the World?" *American Weekly*, March 8, 1959.
3. Stephane Groueff, *Manhattan Project: The Untold Story of the Making of the Atomic Bomb* (Boston: Little, Brown and Co., 1967), p. 352.

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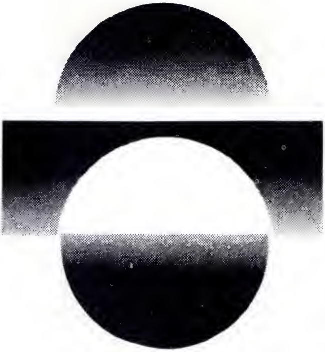
*If the core melts, existing reactor safety systems would be unable to cool it and a core *melt-through* would follow. The molten core would melt through the pressure vessel, containment building, and sink into the earth below, the 'China syndrome.'



SOLAR TECHNOLOGIES

As civilization approaches the end of an era of cheap fossil fuels, solar energy offers a promising replacement. But solar energy is by no means inherently pollution-free, as some have supposed, and there are other limitations to its development. The authors explore the principal approaches to solar energy conversion and argue for continued diversity as society gears up to harness the power of the Sun. The first in a *Bulletin* series.

Frank von Hippel and
Robert H. Williams

In the face of the increasingly pessimistic outlook for oil and gas availability, environmental concerns about coal-fired and nuclear power plants and rising energy prices, solar energy is being looked upon as a potential major energy source for the long-term future. The purpose of this article is to briefly survey some of the basic characteristics of alternative solar conversion systems so as to help show the inherent relative promise and limitations of different systems.

Solar energy (in the form of hydroelectric power) today supplies only about 4 percent of the 75 quadrillion Btu of energy consumed in the United States [1].* The Energy Research and Development Administration sees the solar share expanding considerably in the decades ahead, until perhaps 25 percent of the nation's energy would come from solar technologies by the year 2020 [2]. However, it is interesting to note that our reliance on solar energy is much greater than these figures suggest. If the definition of our energy budget is broadened to include all the energy sources that power our life support system, then solar energy is overwhelmingly our dominant energy source.

Consider first photosynthesis, the process by which the Earth's inhabitants are provided with food, fiber, wood and pulp products as well as the forests, meadows, and cultivated greenery that we enjoy in outdoor recreation. While the solar energy converted to plant matter in continental United States each year amounts to about 100 quadrillion Btu, the amount of sunlight used in this process is actually much greater. Plants must transpire some 500 pounds of water for each pound of dry plant matter produced. The solar energy input for this evapotranspiration is on the order of 10,000 quadrillion Btu or 20 percent of the solar energy falling on the United States each year.

An even greater amount of solar energy, about 13,000 quadrillion Btu, is used in evaporating (and in the process desalinating) seawater to provide most of the 30 inches average annual rainfall in the United States. This rainfall gives us fresh water for direct human and animal consumption; it gives us fresh water for our rivers, lakes and streams for transportation and outdoor recreation; and it provides for the transpiration needs of plants.

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*Btu = British thermal unit. One Btu is the amount of heat required to raise the temperature of one pound of water approximately 1° F.

The energy measure used here, 1 quadrillion Btu = 10^{15} Btu, is equivalent to roughly 40 million (40×10^6) tons of coal or 180 million barrels of oil.

Overall, evaporation of water from oceans and from the land requires on the order of 20,000 quadrillion Btu of solar energy per year for the United States. All other energy inputs are miniscule in comparison. Thus, the 'official' U.S. energy budget, dominated at present by fossil fuel, amounts to only about 0.4 percent of the total energy supply if the total energy budget is redefined to include these solar inputs.

Besides showing the scale of our present dependence on solar energy, these numbers help convey a sense of the immensity of the solar energy resource. But while the solar energy arriving at the surface of the 48 contiguous states is about 600 times the present rate of U.S. energy consumption, it is also both diffuse and intermittent. The average rate at which solar power is received in the United States per unit area of horizontal surface (the average insolation*) is only about 17 watts per square foot [3]. Gathering sunlight and providing it in useful form when needed at competitive cost is the principal challenge to solar energy technology [4].

There is a growing consensus among both solar energy advocates and energy policy analysts that solar energy will first be widely used in the United States to provide water and space heating in homes and in some commercial applications. One of the principal reasons for this optimism is the comparability of the solar energy supply at the household level with the residential demand for heat. In the winter, for example, a typical U.S. home directly consumes fossil fuel for space and water heating at an average rate of about 8 kilowatts. For comparison, the average winter solar power incident on a 1,000-square foot south facing roof top collector would be about 14 kilowatts. Thus a 30 to 40 percent efficient collector would be able to provide 50 to 70 percent of this heating demand. If fuel conservation efforts were pursued simultaneously the area of the collector required could be reduced.

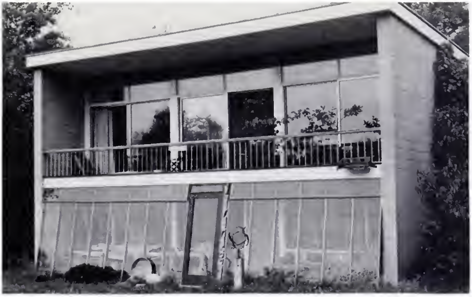

Fig. 1—*Solar Home*. This house in Weston, Mass., was built in 1960. With enclosure of the overhang in front of the basement, about 60 percent of the heating in the winter of 1974-75 was provided by solar energy. Warm air is distributed throughout the house by electric fans. (See n. 6)

This comparability of supply and demand extends to electricity, where there is the possibility that photo-electric cells may one day be widely used to convert sunlight directly to electricity in rooftop units.* A typical household today consumes electricity at an average rate on the order of 1 kilowatt. This could be supplied by a 10 percent efficient photoelectric unit covering 600 square feet of a south facing roof.

The principal obstacle to the immediate widespread adoption of solar energy for homes is the high capital cost, mainly of the collector and storage system.

In order to provide solar energy when the sun doesn't shine a storage system is required—for example, hot water or hot rocks for solar heat and batteries for solar electricity. Capital costs limit the period of overcast skies for which it is economically advantageous to provide storage. To store enough heat for a winter week of overcast skies would require a very well insulated water tank with about 1,000 cubic feet of capacity for the household that consumes fossil fuel at an average rate of about 8 kilowatts. And to store a week's supply of electricity would require several tons of lead-acid storage batteries for the household that consumes electricity at a rate of about 1 kilowatt.

The large extra costs involved in designing solar storage systems to meet infrequent peak demands have led designers to focus on schemes with thermal storage capacities of perhaps 2 days and electrical storage capacities of less than a day. Back-up fuel burning heating systems and a connection to the electrical utility are therefore required.

The capital cost issue for solar energy can be expressed in terms of the economically allowable cost per square foot of collector. Over a 6 month heating season a 40 percent efficient collector could save, for each square foot, the equivalent of three-fourths of a gallon of heating oil (30 cents) or 20 kilowatt hours (60 cents) in the case of a house with electric resistance heat. To realize these fuel savings, however, a prospective homeowner may have to pay more for a solar home. A total additional investment, including storage, of $3 per square foot as a replacement for oil heat or $6 per square foot as a replacement for electric resistance heat would be justified at present fuel prices for a 20-year mortgage at 9 percent interest. The prospects for reducing capital costs to $3 per square foot for systems using rooftop water cooled solar collectors are not good for most of the designs currently being promoted [5]. However, simplified designs such as those used in houses built by H. Thomason in the Washington, D.C., area may already be in this cost range [6].

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*Insolation includes both direct ('incident') and diffuse solar radiation. The solar insolation at the Earth's surface varies with latitude, season, cloudiness, and the dust and water vapor content of the atmosphere.

*Photoelectric cells or solar cells are solid-state devices which collect the radiant energy of the Sun and convert it directly into electric power.

One very interesting possibility for low cost space heating is a house with solar components serving other useful functions. Solar energy, captured by south facing windows, provides over half of the space heating requirements for the house shown in Figure 1 [6]. Massive walls and floors provide the heat storage system, and very careful insulation reduces losses. Slightly recessing the south facing window will exclude the direct Sun in the summer but not in the winter. Houses such as the one shown in Figure 1 underscore the importance of integrating solar collection and storage into the building design from the beginning.

Before photoelectric cells can produce electricity competitively, considerable capital cost reductions will have to occur. If electricity costs twice as much as it does today (not an unlikely development over the next couple of decades), an investment of $10 per square foot or about $1 per (peak) watt would be justified by the homeowner. At present the cost of solar cells alone (exclusive of energy storage, support system, and installation costs) is about $20 per (peak) watt. With concentrators this cost gap can be considerably reduced. Moreover, progress is rapid in this area, and substantial cost reductions through technological innovation and mass production techniques are expected over the next decade or so.

While there do not seem to be significant economies of scale for photoelectric power plants, scale economies do appear to exist for other proposed solar-electric generating systems. Large central station solar power plants would therefore be favored.

Fuel-fired electrical generating plants are based on the conversion of the chemical or nuclear energy of the fuel into heat energy which is then used to run a heat engine, ordinarily a steam driven turbogenerator. Many concepts for generating electrical power from solar energy are based on this same basic technology.

Land-Based. This concept depends upon the solar energy being absorbed and converted into heat in large land-based collectors. It would be attractive to locate such systems in areas where there is a great deal of available space and year-round sunshine. The southwestern United States is a likely area, with average insolation in December about twice the national average.

Unfortunately, like other power plants, solar-thermal electric plants using a steam cycle would require large quantities of cooling water, and water is in short supply in the Southwest. Therefore, designs which concentrate the solar heat at high temperatures (with the associated high efficiencies for converting heat energy into electrical energy), and designs involving rejection of waste heat directly to the air would be favored.

A 1,000-megawatt (electrical) plant in the Southwest would require a collecting area of about 15 square miles if it could convert the incident solar energy to electricity at an overall efficiency of 10 percent. The only comparable commitment of land for a generating station of this size is for a hydroelectric plant with its enormous reservoir. (It should be noted, however, that over the 30-year life of a coal-fired plant with equal output an equal amount of land would have to be surface mined for the coal if the coal seam averaged 7 feet in thickness.)

Some of the principal economic challenges to land-based thermal-electrical energy systems are the same as those facing residential heating systems: bringing down the costs of collectors and energy storage.

Ocean-Based. This concept uses the tropical or subtropical ocean surface as both a free energy collector and a heat storage device. The basic idea is to make use of the temperature difference (typically 25° F or more) between warm surface waters and cold bottom water in these regions to run a heat engine for electrical energy production. Because of the low temperature of the heat source, the ocean thermal plant is very inefficient, converting only about 2 percent of the heat extracted from surface waters to electricity.

Heat exchanger design is one of the principal technological challenges in this concept. To operate the heat engine most effectively, within the constraints of the small temperature differences involved, requires exchanging heat between the ocean waters and the working fluid of the heat engine with the least possible change in temperature. Heat exchangers with large surface areas are required to accomplish this. These heat exchangers dominate the capital cost of this system. In research and development particular attention is being given to developing special surfaces with improved heat transfer properties.

The Gulf Stream is a potentially attractive site for establishing an ocean thermal gradient system. This is because the useful energy flowing through a cross-sectional area is concentrated by about a factor of 1,000 relative to that of the average solar insolation on land, even with the extracted heat limited to what is available with a 1° F temperature drop in the warm surface water passing over the heat exchanger.

If we extracted too much energy from the Gulf Stream, we would seriously affect the climate of Western Europe. This would probably not happen, however, until exploitation reached quite a high level. The current electrical energy demand of the United States could be met from this source with a temperature drop of the Gulf Stream of only about 0.5° F. It is not known whether this would be 'too much.'

An alternative, which would not raise this concern, would be to build plants which 'graze' relatively still areas such as in the Gulf of Mexico. A 1,000-megawatt (electrical) plant, or group of plants with this capacity,

Fig. 2—***Two approaches to wind power.*** **Left: 10,000 water pumping windmills cover a plain on the island of Crete. Right: a huge (6.5 megawatt electrical) wind power generator dwarfs a farmhouse in this sketch illustrating a proposal made in 1945 by Percy Thomas of the Federal Power Commission. (See "Solar and Aeolian Energy,"** ***Proceedings of International Seminar on Solar and Aeolian Energy,*** **Sounion, Greece, Sept. 4-5, 1961; and n. 9)**

would have to graze about a 1,000 square mile area in order to sustain a surface temperature drop no greater than 2° F. This area is so large because more than 90 percent of the incident solar energy would be lost by the ocean directly to infrared radiation and evaporation—the ordinary cooling processes of the ocean.

Some proponents of the ocean thermal gradient scheme suggest that a major side benefit could accrue from the nutrients brought up from the ocean depths along with the cooling water. Natural upswellings of deep ocean water (off Peru for example) are associated with rich fisheries. It should be pointed out, however, that bringing this cold water to the surface in this variant on the ocean thermal gradient scheme could also cause a net transfer to surface waters of inorganic carbon from the carbon-enriched bottom waters.

Most of the excess carbon would pass into the atmosphere as carbon dioxide [7]. In the absence of compensating effects, if the cold water is not returned to the depths, an ocean thermal gradient plant would release about one-third as much carbon dioxide to the atmosphere per kilowatt hour of electricity produced as a fossil-fueled plant. Since the buildup of carbon dioxide in the atmosphere from the burning of fossil fuels is a major environmental concern [8], it would be unfortunate if solar energy were developed in a manner which would exacerbate this problem.

A potentially serious constraint on this concept may arise if ocean thermal gradient plants are developed on a large scale. Except for a few sites near islands, such as Hawaii and Puerto Rico or off the coast of the Southeast United States, the difficulties of long distance underwater transmission of the generated electricity would tend to discourage utility interest. Proponents have suggested that if the power became sufficiently cheap, electricity could be converted into more transportable energy forms such as hydrogen. Alternatively the transmission problem could be avoided if energy intensive industries were located near ocean thermal gradient sites, just as, for example, aluminum refineries have been remotely sited in the past to take advantage of low cost hydroelectric power.

Similar energy transmission problems would also arise for a large land-based solar development in the Southwest or a wind-electric system in the Aleutians. Conversion of cheap solar energy into an easily transportable form therefore deserves study in its own right.

It should be emphasized, however, that there are sites where the energy transmission problem would not be serious and that initial economic studies of the ocean thermal gradient concept are encouraging. Further development of this technology with a pilot plant at a suitable location therefore appears to be warranted.

The step involving the greatest energy losses in the conversion of solar energy to electrical energy in thermal systems is that step in which the heat is converted to mechanical energy. It is of considerable interest therefore that thermal energy originally from the Sun is made available as mechanical energy by natural processes on a large scale, notably in the form of wind and waves. A few percent of the solar influx generates the great atmospheric pressure systems which drive the winds which, in turn, generate the waves.

The energy associated with wind can be more concentrated than the original solar influx from which it arises. At a favorable location, a typical wind velocity at a couple hundred feet above ground level is 20 miles per hour. At this velocity the power through a surface perpendicular to the wind is 45 watts per square foot, or nearly 3 times the average solar insolation on the ground. The high quality of this mechanical energy is demonstrated by the fact that a windmill can convert to electricity about one-third (ideally, 16/27 or about 59 percent) of the energy incident on the area swept out by the propeller. Thus a wind of 20 miles per hour would yield nine times as much electric power per unit area as a 10 percent efficient solar thermal unit.

An important characteristic of wind is that the power developed increases as the cube of the wind velocity, so that the power available

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at 25 miles per hour is about double that available at 20 miles per hour. This means that the average power developed by a windmill can be considerably greater than the power produced from a wind of average speed.

Large-scale development of wind power would lead to a proliferation of windmills. To get a feeling for the scale involved, consider a system of 200-foot diameter windmills. Replacing all of today's electrical generating capacity in the United States with windmills would require arrays of some one million of such windmills which, if lined up side by side, would stretch 40,000 miles. The number of windmills involved is on the same order as the number of transmission towers for high tension lines in the United States.

It is not obvious that the climatic impact of such intensive use of the wind would be negligible. Aesthetic considerations would also have to be taken seriously, as a comparison of the windmills in Figure 2 suggests.

Windmill power would appear to require energy storage for times when the wind is not blowing. However, as Percy Thomas [9] pointed out in his classic 1945 study on wind power, when the wind dies down in Philadelphia it may be blowing in New York. The required storage capacity can be reduced considerably therefore by feeding electricity from dispersed windmills into a regional electric power transmission grid. Thomas did some preliminary surveys which suggested that such an arrangement would substantially reduce the fluctuations in wind-generated power. A high priority for wind power research should be to pursue such studies in greater depth for specific proposed distribution of wind generators.

The engineering knowledge required for optimized windmill design is mature relative to the state of development for other types of solar electric power plants. It should be possible to decide in the near future whether or not deployment of windmills is economically justified. Preliminary capital cost estimates seem to be 'in the right ball park' to justify the deployment of full scale demonstration plants at appropriate sites

[10]. Moreover, the relatively small unit sizes of windmills and the corresponding large numbers needed to produce appreciable generating capacity make windmills well suited for cost cutting mass production techniques.

For a wind of about 20 miles per hour, a fully developed 'sea' in the open ocean has waves about 5 feet high from trough to crest. Such a sea carries an average power of about 5,000 watts per linear foor [11], which is comparable to the wind power intercepted (per foot of propeller diameter) by a large windmill operating in similar wind conditions. Wave power, like wind power, is high quality mechanical power. The potential for harnessing wave power should be assessed and the economics compared to wind power.

As we have already pointed out, there do not appear to be substantial scale economies for Earth-based photoelectric converters. However, one glamorous proposal for harnessing the Sun involves converting sunlight to electricity with photocells at a space station in geosynchronous orbit [12].

Putting these power stations in orbit would require great effort, however. If the United States (or the world) should take this option seriously, it is reasonable to expect that these plants would come on-line at least as fast as some 10,000-megawatts (electrical) per year. (This corresponds to $2^1/_2$ percent of U.S. generating capacity today.) Putting 10,000-megawatts (electrical) of space station generating capacity into operation per year would involve at least two space shuttle flights per day, given a payload capacity of 65,000 pounds and an estimated space station weight of 5 pounds per kilowatt [12].

Such intensive shuttle activity could have harsh environmental impacts. Chlorine from rocket exhaust is especially worrisome, given the intense concern lately about the effects of chlorine on the stratospheric ozone layer [13,14]. A recent environmental impact study of the space shuttle [15] showed that over 100 tons of chlorine would be dumped directly into the stratosphere as hydrochloric acid for each shuttle flight. At two shuttle flights per day, chlorine would be introduced throughout the stratosphere as fast as the maximum rate of stratospheric chlorine production in 1980 likely to result from the release of freon at ground level [13].

This would probably be unacceptable. Other technological options exist for putting these stations in orbit but they are not being developed. This calculation points up a potential serious impact of space shuttle operations generally on the ozone layer [15]. It also demonstrates the importance of closely scrutinizing all parts of a system in a feasibility study.

Photosynthesis is attractive as a solar energy conversion process because, unlike most solar schemes, it provides in plant material a natural, convenient energy storage medium. Moreover, burning plant material, unlike fossil fuels, would not lead to a net atmospheric build-up of carbon dioxide and the climatic consequences implied by the build-up because, on the average, plants would be grown as fast as they are burned. But photosynthesis is the least efficient solar conversion system commonly considered. Theoretically, photosynthesis has only a 5 to 6 percent maximum net efficiency for the conversion of natural sunlight into chemical energy. Practical efficiencies are far less. In tropical bogs nature is at her best with a 4 percent photosynthetic conversion efficiency. Typical annual average values for U.S. agriculture are in the range 0.25 to 0.75 percent.

One hundred years ago the conversion of solar energy to organic materials through photosynthesis provided the primary source of power and heat for the population of the United States in the form of fuel wood and work animal feed. Since that time, however, the U.S. population has increased about 4.5 fold and our per capita energy use has increased about 2.5 fold [16] for a total growth in energy consumption of more than a factor of 10. Accordingly, while photosynthesis can potentially provide a significant fraction of total energy needs, with low photosynthetic conversion efficiencies it would appear unlikely that we can 'go back to the good old days' to a complete reliance on this source because of land use constraints.

Because efficiencies are so low, a sensible approach to using photosynthesis for energy production would be to use by-products of other economic operations based on photosynthesis. A prime candidate is our food production system. The incentive to grow crops for food production is clearly greater than that for growing crops for fuel: the farmer gets about $45 or more per barrel of oil equivalent energy in the wheat he sells as food, or 4 times the price of a barrel of imported oil.

However, there is a great deal of energy-rich (if not food-rich) organic material generated as a by-product of our food production system. The harvest taken from U.S. fields represents, on the average, only about one-half of the mass of the plants (dry weight exclusive of roots). In addition, a significant fraction of our grains and soybeans are used as animal feed, and typically 25 to 30 percent of the food energy ends up in excrement.

A recent study by Poole [17] provides a careful analysis of the energy resource potential of these and other organic wastes. Of the 690 million tons (dry weight) of organic wastes produced each year in the United States, about 340 million tons are crop residues and 200 million tons are manure. At 16 million Btu per dry ton these agricultural wastes represent a resource base of some 8.6 quadrillion Btu per year (11 percent of U.S. energy consumption in 1973). Not all of these wastes are recoverable, however. Economic constraints limit crop residue recovery below some minimum areal density and only a fraction of the manure is available in feedlots where it is sufficiently concentrated for economic recovery.

Solar energy is of great interest in our society today, as we come to the end of an era of 'cheap' fossil fuels.

Losses also occur in converting the energy to a convenient form. One especially attractive conversion process, the production of methane via bacterial digestion under anaerobic conditions, has an efficiency of 37 to 55 percent. For this process, plant nutrients remain concentrated in the residuum, which can either be returned to the soil as fertilizer or converted to a protein feed source for animals. Poole finds that, with the various losses taken into account, the by-product methane potential from our food system would amount to 2.5 to 4.0 quadrillion Btu per year, corresponding to 10 to 20 percent of the current natural gas production rate. Unlike natural gas wells these wells would not run dry.

In this brief overview we have attempted to show how the varied technologies for exploiting solar energy compare to one another. In such limited space our analysis of alternative options is necessarily oversimplified. The basic point we wish to make is that a good understanding of the physical advantages and limitations of different options is necessary to provide a solar R&D program with a rational basis. In particular, systems studies of the implications of large scale development of the alternative schemes would be helpful in shaping the solar energy program.

With a few examples we have tried to dispel the popular notion that solar energy is inherently pollution free. All energy systems involve some pollution, and solar energy is no exception. We have suggested how potential impacts could range from the atmospheric build-up of carbon dioxide to ozone destruction. Resource availability, such as water for cooling, may prove limiting for some options. With thoughtful system design much can be done to minimize such environmental and resource problems. However, these considerations underscore the importance of maintaining a diversity of conversion concepts in developing solar technology, so as to avoid reaching 'limits' for any particular concept. These considerations also point up the importance of coupling solar energy development to aggressive energy conservation programs. If solar energy is to capture a significant fraction of our energy budget, our energy budget must not be too large.

Compared to other energy technologies the capital costs of solar energy are often high. But solar energy is nevertheless of great interest in our society today, as we come to the end of an era of 'cheap' fossil fuels, with no assurance that we are entering a new era of 'cheap' nuclear energy. Moreover, solar energy is a resource with potentially great promise, especially in the forms of wind power and photosynthetic energy, for the energy hungry developing nations, where conditions for exploiting this resource are often favorable and per capita energy consumption is low.

Notes

1. U.S. Bureau of Mines, "U.S. Energy Use Down in 1974 After Two Decades of Increases," News Release (Washington, D.C.: The Bureau, April 3, 1975).

2. U.S. Energy Research and Development Administration, "National Solar Energy Research, Develnpment, and Demonstration Program, Definition Report" (Washington, D.C.: ERDA, Aug. 6, 1975).

3. This is only about 13 percent of the solar flux in space near the Earth. The space solar flux is reduced by a factor of four on the average due to the fact that the area of the Earth's disk perpendicular to the Sun is only one-fourth the total surface area of the Earth.

A further reduction averaging approximately a factor of two over the globe results from reflection from clouds, dust and the individual molecules in the atmosphere and from absorption in the atmosphere. Aside from atmospheric conditions, the solar flux on a horizontal plane at the Earth's surface depends on the latitude.

4. For an excellent introduction to a large number of 'do-it-yourself' solar projects, see: *Energy Primer: Solar, Water, Wind, and Biofuels* (Menlo Park, Ca.: Whole Earth Truck Store/Portola Institute, 1974).

5. The capital cost issue was put into perspective for us by Ray Bliss, a pioneer in the solar-heating field. Bliss said, "twenty years ago I thought, 'wouldn't it be wonderful for solar energy if the price of heating oil went up by a factor of 3.' Now it finally has. Unfortunately, in the meantime so has the capital cost of construction."

6. For an excellent descriptive listing of solar heated buildings, see W. Shurcliff, "Solar Heated Buildings: A Brief Survey," which is available from the author (19 Appleton St., Cambridge, Mass. 02138; $7 postpaid).

7. Surface waters contain about 3.5 milligrams per liter less inorganic carbon than water below 1,000 meters. A buffering action in surface waters gives rise to the phenomenon that the fractional increase in the partial pressure of carbon dioxide is much greater than the fractional increase in the total inorganic carbon concentration. Hence, most of the excess inorganic carbon brought into the surface layer passes into the atmosphere as carbon dioxide. See R. H. Williams, "The Greenhouse Effect for Ocean Based Solar Energy Systems," Working Paper No. 21 (Princeton, N.J.: Center for Environmental Studies, 1975). For a recent detailed discussion of the exchange process for carbon dioxide between the ocean and atmosphere, see Charles D. Keeling, "The Carbon Dioxide Cycle: Reservoir Models to Depict the Exchange of Atmospheric Carbon Dioxide with the Ocean and Land Plants," in *Chemistry of the Lower Atmosphere*, ed. by S. I. Rasool (New York: Plenum Press, 1973).

8. Evidence is presented in a recent article that suggests that the present global cooling trend may be one phase of a long-term climatic cycle which can be expected to end soon. Subsequently we should expect a pronounced global warming from increased carbon dioxide in the atmosphere For details, see Wallace S. Broecker, "Climate Change: Are We on the Brink of a Pronounced Global Warming?" *Science*, 189:4201 (August 8, 1975), 460-463.

9. Percy H. Thomas, *Electric Power from the Wind* (Washington, D.C.: Federal Power Commission, 1945).

10. See, for example, Bent Sorensøn, "Energy and Resources," *Science*, 189:4199 (July 25, 1975), 255.

11. See Willard Bascom, *Waves and Beaches* (Garden City, N.Y.: Doubleday, 1964), pp. 53, 244. Wave energy increases slightly more rapidly than the wave height squared.

12. Peter E. Glaser, "Space Solar Power: An Option for Power Generation," paper presented at 100th Annual Meeting of the American Public Health Association, Atlantic City, N.J., Nov. 14, 1972.

13. R. J. Cicerone, et al., "Stratospheric Ozone Destruction by Man-Made Chlorofluoromethanes," *Science*, 185:4157 (Sept. 27, 1974), 1165-1167.

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The United Nations after 30 years

It mirrors a discordant world. But, with all its flaws, the organization still embodies mankind's best hope for survival. What would the world do without it?

Benjamin M. Becker

During the last days of the 29th session of the U.N. General Assembly, the U.S. Ambassador to the United Nations, John Scali, warned the General Assembly that the United States is deeply disturbed by actions of the world body and that U.S. support is eroding; that the unrealistic resolutions passed by the United Nations had become a "clear and present danger" to its usefulness; that "if the United Nations ceases to work for the benefit of all its members, it will become increasingly irrelevant. It will fade into the shadow world of rhetoric, abandoning its important role in the real world of negotiation and compromise"; that "they [Americans] are concerned by moves to convert humanitarian and cultural programs into tools of political reprisal," and that neither the American people nor the U.S. Congress believe that such actions can be reconciled with the spirit or letter of the U.N. Charter.

When the Arabs threatened to use their bloc power in the General Assembly in June 1975 to unseat and expel the State of Israel, it was reported that if this should come to pass it might bring about a walkout by the United States, and probably cause the U.S. Congress to cut contributions to the United Nations. More recently, practically on the eve of the opening of the 30th session of the United Nations, Secretary of State Henry Kissinger re-emphasized the disenchantment of the U.S. government and the American people with the United Nations. He stated, "If the United Nations begins to depart from its Charter, where suspension and expulsion are clearly specified prerogatives of the Security Council, we fear for the integrity and the survival of the General Assembly itself and no less for that of the

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specialized agencies." He concluded that "the future of the United Nations is clouded."

As Irving Kristol has observed, "An almost infinite number of other legalistic absurdities can be found in the shelf-full of U.N. resolutions—on 'human rights,' 'self determination,' 'the abolition of poverty and hunger,' etc., etc.—we have automatically and unthinkingly subscribed to. Other nations, of course, pay no attention to them and never had any intent to do so. We, in contrast, are very solemn about them and are constantly exposing ourselves to—indeed, are constantly encouraging—a barrage of criticism and self-criticism." (*Commentary*, July 1975, p. 54.)

It is thus appropriate for Americans and the U.S. Congress to take a look at the United Nations today. A few years ago I took a look and wrote a book entitled *Is the United Nations Dead?* It considered then whether or not continued American support of the United Nations was warranted, despite its failures and our general disenchantment. The conclusion was reached that despite its ineptness the United Nations was the only nearly universal international organization which could possibly someday provide the framework for international cooperation to tackle many of the pressing global problems which faced all of humanity; that U.N. participation in ceasefire and peacekeeping operations in the Mideast and elsewhere and its extensive work in the social and economic field were sufficient justification for continued U.S. support.

Much has happened since that book was published, however. China was substituted for Taiwan as a member. Many more nations have been admitted. The membership grew from 111 to 138 at the last count. The United Nations has involved itself in many more areas of economic concern to member nations. The United States has lost influence among member states and began to use its veto in the Security Council. The Afro-Asian-Arab-communist bloc has developed an overwhelming majority in the General Assembly.

On the positive side, thrice in the past three years the United Nations has been called upon to supervise cease-fires and keep the peace, twice in the Mideast and once in Cyprus. It appeared as if the United Nations had come alive.

But nothing in recent years has so greatly diminished the United Nations in the view of many people as some totally irresponsible actions taken in the last two months of the 1974 session.

The invitation to Yasir Arafat to present his appeal to the General Assembly was a craven surrender to political expediency.

- There was the General Assembly's invitation to the terrorist Palestine Liberation Organization leader Yasir Arafat to present his appeal to the General Assembly in New York. Arafat, with gun in holster, pleaded for the creation of a Palestinian state and to eliminate the State of Israel to which the United Nations had given birth some 26 years before. Arafat is the man who is the commander of Fatah-Black September group. He personally received $5 million from President Qaddafi of Libya as a price for the slaughter of Israeli sportsmen at the Olympic games. He personally directed the murder of diplomats in Khartum; and told the Italian weekly L'Europeo, "Our goal is the destruction of Israel. Peace for us means Israel's destruction, nothing else." Three of Arafat's guards in New York were the same men who had been involved in the killing of the three diplomats at Khartum, including one American. Yet, Arafat was received with resounding applause by the overwhelming majority of U.N. members.

This was the United Nations which for more than four years has failed to act to stop international terrorism. The invitation to Arafat was a craven surrender to political expediency of the worst kind, an acknowledgement that terrorism and violence was the road to international recognition. It was a surrender to barbarism. As the New York Times editorialized, "It is grim irony that virtually the same Assembly majority that suspended a founding member of the United Nations one day could on the next enthusiastically welcome the leader of a terrorist organization whose goal is the destruction of another state."

- For the first time in its history, the U.N. General Assembly voted to gag a member nation (Israel), denying it the right to speak more than once during the heated debate on the Palestinian question, notwithstanding the fact that there were some 75 to 90 Arab, Third World and communist bloc nations ready to take the rostrum in opposition to Israel.
- There was the arbitrary, capricious suspension of South Africa from the U.N. General Assembly. This was clearly illegal and a violation of the U.N. charter.
- There was the attempt to oust the Cambodian government, headed by Marshall Lon Nol, and to replace it with the exile regime of Prince Norodom Sihanouk. It failed by the narrowest of margins.
- The overwhelming General Assembly action against Israel after the debate on the Palestinian question was quickly followed by irresponsible actions against Israel by Unesco: the resolutions expressing hostility to Israel, which weakened her status in the agency; barring Israel from Unesco's European region without admitting her to any other regional grouping; cutting off Unesco's modest aid to Israel ($24,000 in 1973-1974 for cultural institutions), notwithstanding Israel's past contributions to Unesco, which in financial terms far exceed what Israel has received from Unesco; and inviting Unesco's new director general to supervise educational and cultural institutions in territories under Israeli occupation in cooperation with the Arab states concerned and with the Palestine Liberation Organization. In contrast, no action was taken against member nations who harbored hijackers, kidnappers, mur-

derers and the like.

- Once again the U.N. General Assembly voted to postpone debate on the problem of international terrorism until the following year. Israel was the only nation voting against the postponement.
- On December 12, 1974, the General Assembly approved a highly controversial economic declaration called the "Charter of Economic Rights and Duties of States" by a vote of 120 to 6, with the United States, Britain, West Germany, Denmark, Belgium and Luxembourg voting against the charter. Under the declaration every nation would have full sovereignty over all its wealth, resources and economic activities, the right to regulate foreign investments in accordance with its laws and to supervise transnational corporations within its jurisdiction.

The basic objections to the new declaration involved the provisions permitting expropriation of foreign properties without guarantee of equitable compensation under international law. With the sanction of the seizure of property without any guarantee of compensation, as the Chicago Daily News editorialized, "this could be construed as an open license to steal" and illustrated "the paucity of principle in the U.N. General Assembly."

New Nations Dominate

Small nations clearly now dominate the United Nations. When the United Nations was founded in 1945 there were 51 members, and now there are 138. The new members, who have emerged from colonial status since the end of World War II, now command the majority of votes and steer debate in areas of their interests. With the close of the 1974 session of the U.N. General Assembly it was clear that the United States had lost whatever influence it had. Appeal to reason fell on deaf ears.

Somewhat petulantly, on December 17, 1974, the United States decided to boycott a special fund set up by the United Nations to provide emergency relief and development aid to the countries hardest hit economically. The U.S. action was interpreted as a retaliation for the controversial action taken by the Arab, African, Asian and communist bloc nations in the United Nations.

The American people and the U.S. Congress now are faced squarely with the question of whether to continue their support of the United Nations. The problem is not easily resolved. The United States contributed approximately one-third of the entire cost of the United Nations and its varied operations. Is it in the United States national interests to continue to support the United Nations?

It behooves nations and leaders to strengthen the United Nations step by step for that day when its availability will be crucial —and that day is now.

It will take a largeness of perspective to recognize that the United Nations should continue to be supported and that the task of getting it to work effectively in accordance with charter principles is something that involves a longterm undertaking, continuing commitment and the utmost patience and fortitude.

Impartial critics recognize that it is not the structure of the United Nations, but the conduct of its members which is largely responsible for its failures in many areas. That aside, the United Nations has served well, considering the limitations imposed upon it by its members. To state the case very briefly, there is much that has been accomplished by the United Nations: *There are* the many U.N. supervised cease-fires and peacekeeping undertakings—in Korea, in the Mideast on numerous occasions, in Africa, and in Cyprus. There are the continuing day-to-day economic and social welfare programs and operations in underdeveloped nations. There is the continuing identification and study of potentially disastrous global problems, such as the population explosion, pollution of the environment, hunger and nuclear proliferation. There is the sponsorship of and planning for world conferences on the human environment (Stockholm), population (Bucharest), food (New York), hunger (Rome), law of the sea (Caracas), disarmament (Geneva), and narcotics control. And, lastly, there is the continuing availability of the United Nations as a central place for international multipolar diplomacy and off-the-record discussions involving critical world problems.

To be sure, the United Nations may be short of definitive accomplishments in many areas. But it does serve important purposes.

Has the United Nations fallen so far short of the high and noble aspirations and hopes of its founders and supporters that it is time to call it quits and let it go the way of the League of Nations? As New York Times columnist William Safire notes: "This has not been [the recent actions on South Africa and the Mideast] a victory of the U.N.—rather, a victory over the U.N.—and the organization that could still be helpful in averting World War III has been made the breeding ground for the Third World's War."

Before we bury the United Nations, let us ask: What would the world do without the United Nations?

What would have happened on the outbreak of hostilities in Korea in 1950 without the U.N. participation? True, it involved minimal participation by nations other than the United States. But would it have meant United States entry into hostilities independently, perhaps another Vietnam?

What would have happened without the United Nations on the outbreak of hostilities in the Mideast in 1957, 1961, 1963, 1967, 1971 and 1973? Each of the principals had their patrons, the Soviet Union and the United States. What would have happened had hostilities continued without the intervention of the U.N. cease-fire and peacekeeping assistance? Certainly the cease-fires and peacekeeping were encouraged by the United States and the Russians; but the United Nations provided the format for easing the difficult step

The major focus for the building of a world order guaranteeing peace, justice and progress for all peoples.

from active hostilities to cease-fire and peacekeeping.

The same questions may be posed in connection with Cyprus, Africa, and the India-Pakistan hostilities. What would we have done without the United Nations?

But there was a United Nations. There was a hastening to the United Nations to bring each crisis before the Security Council. Here was a ready-made international forum for the statement of positions by the combatants and their supporters, a place for giving vent to their feelings, and yet a central point for quick, but quiet, diplomacy and negotiations to move toward a cease-fire, and then to some reasonable posture of peace.

Here was an organization with experience in organizing and maintaining a cease-fire, as it had on other occasions in the Middle East and elsewhere. To be sure the United Nations could act only when the superpowers agreed, persuaded and pressured the combatants to agree. But the United Nations was there to follow through and implement such agreements. As at this writing U.N. peacekeeping forces are in place in the Mideast and in Cyprus.

Global Problems

But there are more compelling reasons for the existence of the United Nations and for strengthening it so that it can act more effectively. Apart from the danger of nuclear war and devastation, there are the rapidly worsening global problems which threaten all people and nations. These problems cannot and will not be solved by summitry, the balance of power approach, or tenuous detentes; but only by a global approach in the form of a strong international body which can act effectively. Appropriately strengthened and utilized the United Nations *can* be such an organization.

Most of the critical problems of our time are universal in character. No nation is immune from the disastrous effects of the failure to grapple with these world problems:

- Radiation fallout from nuclear testing in any part of the world is of concern to all peoples and nations.
- Hunger and impoverishment of more than half of the world's population is a matter of international concern. Revolution is born of desperation.
- Disease has no national boundaries.
- Pollution and despoliation of the environment is worldwide.
- The economic interdependence of nations has been demonstrated time and time again. The weakness of the American dollar has its reverberations throughout the world. Monetary imbalances seriously affect the economies of all trading nations. The current oil crisis has worldwide repercussions and dramatically demonstrates the interdependence of nations.

Only with a common vision and purpose can nations even begin to attack problems with worldwide consequences. As the massive problems of environment and atmospheric pollution, exhaustion of natural resources, poverty and health are exacerbated and we come closer to the days of reckoning, there will be—and there is now—a growing realization of the need of a global and universal approach to the easing of these problems. Here is where the United Nations some day may be found to be indispensable as the only truly available universal organization—not perfect to be sure in its organization and operations, but yet the only truly global organization standing ready to tackle the monumental tasks facing humanity.

Imperfections in United Nations organization will become less important when world problems involving survival transcend national boundaries and nations are impelled to work together with a common purpose. Weak as it is now, the United Nations is doing what it can about these global problems. They have, as mentioned above, sponsored world conferences on population, pollution, and hunger. And in April 1974 there was the special session of the U.N. General Assembly on the subject of raw materials—another global emergency facing both poor and rich nations; and this also involved the existing and anticipated mass poverty in the underdeveloped and developing nations, the tragic consequences of the population explosion, the frighteningly low supply of food to feed the world population, the energy crisis, the massive military expenditures, and the worldwide inflation. U.N. Secretary-General Waldheim called it a "global emergency" of massive proportions.

Then, of the 135 member-nations, 96 were classified as developing countries which, in turn, encompassed 70 percent of the world's population. As U.N. Secretary-General Waldheim said, the problems

> affect the lives of virtually every man, woman, and child on Earth. It holds vast significance for future generations. It raises the fundamental question of the

kind of world economic system and social order we wish to establish and live under. It challenges us to make a series of rational and agreed choices which may be decisive in determining the quality and condition of mankind's future life on the planet.

There is also the critical problem of a global approach to the task of eliminating the pollution of the world waterways and utilizing the seas as a source of food and raw materials. This involves 70 percent of the Earth's surface, and the utilization of the oceans as a source of food supply for the world population. The Caracas Law of the Sea Conference in 1974 made at least a start in tackling this difficult problem.

The universal urgency of solving, or at least easing, the pressing global problems may well transcend disagreements on nuclear arms control for at that point our very survival will be at stake. Sovereignty will need to bow to the primacy of survival. The past failures and ineptness of the United Nations may then be viewed as part of the growing-up process by which nations learn to work together in peaceful co-existence, striving cooperatively to survive. In the meantime, it behooves nations and leaders to strengthen the United Nations step by step for that day when its availability will be crucial—and that day is now.

It is reasonable to assume that at least in the foreseeable future there will be no definitive resolution of the basic ideological conflict and differences which now divide the world. Yet, it is equally reasonable to assume that the economic interdependence and the mutual interests of nations in solving and easing the crucial world problems will necessitate expanding areas of cooperation despite basic differences. There is evidence of this all around us.

It is a much different world in which we live. Global problems require a global approach and a global approach involves effective international organization. And there is in existence today only one truly universal organization, the United Nations. As Richard J. Walton has noted, "It is easy to scorn the United Nations but can anyone suggest an alternative? Or imagine the world without it?"

What indeed will it take for the nations of the world to realize the potential of the United Nations? After 10 years, as the late U.N. Secretary-General, U Thant said,

> What is required, of course, is a common global ethic [which, of course, we do not have, except in time of catastrophe], which the human society as a whole wishes implemented. . . . When I am asked what I see as the key to a world order that is adequate to assure peace, justice, and progress . . . the need for such a global ethic is always the first of three major considerations that come to my mind. The others are modifications of the notion of national sovereignty [hardly conceivable with the revival of nationalism among nations] and structural adjustments in the world organization [which none of the major powers would support]. (*World*, July 4, 1972, p. 38.)

But the situation is not without hope. There *is* a growing 'planetary awareness,' with the increasing concern about the common global problems of environment, poverty, health and nuclear war.

As the global approach to international problems is expanded, the United Nations conceivably can come into its own. In the meantime, the maintenance of even a tenuous and relative peace and co-existence can give us time. Time is on the side of peace. And the United Nations, with its proven capacity to provide a forum for discussion of international controversy and its extensive experience in supervising cease-fires and peacekeeping can give us the time.

With or without major structural changes, again as U Thant has noted, "There is no alternative to the United Nations as the major focus for the building of a world order guaranteeing peace, justice and progress for all peoples." Going and looking to the United Nations may yet become a pattern of international life.

No, the United Nations is not dead! It is reborn with each major crisis. It deserves continued U.S. support.

As Secretary of State Kissinger spoke out on July 14, 1975, after reviewing the merits and demerits of the United Nations, "This, then, is the promise and the problem of the United Nations. We must insure that the promise prevails because the agenda we face makes the institution more necessary than ever before. The United Nations, first, faces continuing and increasing responsibilities in its mission, in the famous words of the U.N. Charter, 'to save succeeding generations from the scourge of war.'"

Its agenda makes the institution more necessary than ever before.

What will be needed to procure the enthusiastic and important support of the United Nations by the major powers? Perhaps, as former U.S. Senator J. William Fulbright recently noted, "A long period of trouble and education combined—getting into crises one after another."

But then it may be too late! ☐

Foreign policy debate in a democracy

Carl Marcy

A young lady was recently asked for her opinion on an idea. She answered: "You don't want my opinion, you want me to tell why your idea is great." I was nonplussed.

When the Secretary of State 'consults' with Congress on a foreign policy issue, or seeks the advice of the Senate, is he serious? And if he is serious, does Congress react as the young lady: "You must be kidding—all you want is agreement."

How sincere are repeated offers to consult, or invitations to the public to debate foreign policy? And if there is consultation and debate is it adequate and helpful in formulating a strongly supported foreign policy?

Vice President Nelson Rockefeller has called for U.S. leaders and the public to "devote themselves to building a new consensus by conducting debate on major (foreign policy) issues in an open and responsible manner." This view was expressed by then Governor Rockefeller at a conference well before he could have imagined himself as Vice President of the United States.

If foreign policy debate is to develop a new 'consensus' as we deal with the conflicting demands which Rockefeller finds are emerging—such as "the United States . . . being asked to avoid commitments, but to remain a world leader"—communication must be achieved in words most people understand. George Meany communicates. One may not agree with what he says, but there is no doubt as to his meaning. Unfortunately, the same cannot be said for much of the information which comes out of the Department of State or the Congress or, for that matter, the academic community.

Debate and consultation require blunt, candid communication which is in short supply. Significant debate also requires that information be widely disseminated. A substantial amount of information which does surface through official channels is self-serving and, while it may be true, too often it isn't the whole truth.

In addition to the problems of communication, information and veracity, discussion of foreign policy itself has not been welcomed. Ever since World War II the foreign policy apparatus, whether under the guidance of Republicans or Democrats, has been the preserve of the specialists. In the words of Sen. J. William Fulbright,

> the Executive Branch, aided by many intellectuals, has purveyed the idea that foreign policy is an esoteric science which ordinary mortals, including Congressmen and Senators, [are] too stupid to grasp and which, therefore [is] best left to the experts with their scientific methods of analysis and prediction. (*The Crippled Giant* (New York: Random House, 1972), p. 212.)

Foreign policy, however, requires judgments not crippled by commitments and perceptions of another era or even last year. Furthermore, good judgment—frequently the key to a policy decision—does not necessarily go hand-in-hand with expertise or inside information. Good judgment is not the prerogative of Kings, or Presidents, or Secretaries of State or Defense, or Foreign Service Officers, or committees of experts. Indeed, the fundamental assumption of a democratic form of government is that the judgment of the majority of its citizens, given the facts, is more likely to be better for society than the judgment of the experts.

The war in Vietnam, the diplomatic tilt toward Pakistan, the Bay of Pigs, the CIA intervention in Chile and elsewhere, the concept of a multi-national force to weld NATO together, 'homeporting' in Greece, and the invasion of Cambodia—to name a few U.S. ventures proposed by experts and implemented by the taxpayers—suggest that the judgment of the informed, interested person in the street could not have been much worse for the United States than that of the experts who determined, in secrecy, what they judged was best for us all.

For better or worse, once the Executive Branch of the government decides on a foreign policy course of action—and it may be a one-man decision—it is most difficult to question the decision. The bureaucracy must not dissent. It must try to convince the people of the United States that the Executive decision was right. The State Department maintains mailing lists supplying information in 38 areas of foreign policy; it produces weekly radio shows and a 30-minute monthly television documentary as well as magazines, newsletters, and background notes which cover every subject from Guadaloupe to detente. These media products, many of which are purely factual in nature (the mean summer temperature in Nairobi, for example), on policy issues, never-

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theless, present only the Administration's point of view. Why should they present anything else?

In the field of domestic affairs it is no disgrace to question an Administration policy. But it takes guts to question a foreign policy enunciated by the Executive. To dissent from policy is often viewed as unpatriotic. Even the Senate with its specific Constitutional foreign policy duties is chary of the role of critic. It is too easily branded as 'irresponsible.'

The best and the brightest individuals in the foreign policy establishment, who shift back and forth between the academic world, the big foundations and the government, regardless of political party, become so enamoured of their own policy decisions that they discourage debate and neutralize critics in the bureaucracy. It takes a disaster to make them ask questions—by then it is too late. One of the sad epilogues of the Vietnam war has been the spectacle of able former public servants re-writing their role in decisions which time proved disastrous.

The Executive Branch is not psychologically equipped to question its own judgment. The Congress is hard put to effectively question a Dean Rusk or a Henry Kissinger—they have the 'facts' and a service-oriented bureaucracy to back them up.

The political science academics, with too few exceptions, respect power, admire decisive Executive action, and get along by going along—after all, they too may be called to Washington some day. The more prestigious foreign policy institutions seem to 'educate' the people to the necessity of a non-partisan, unified foreign policy, or to explore exotic subjects of primary interest to other explorers.

It is a small, select group of Americans who are in on the foreign policy take-offs. But it is the nation which suffers if there is a crash. Any passenger bold enough to ask whether the rear cargo door is properly locked is viewed by the professionals as a worrisome nut or nervous Nellie.

There is need for an institution able and willing to ask serious questions about Executive Branch foreign policies and to expose them to the test of free-wheeling, open discussion. The need is for an institution dedicated to truth, openness, balance and recognition that foreign policy in the American democracy is in the final analysis the prerogative of the people and their informed collective judgment.

The public should be in on the take-offs as well as the crash landings; we need an institution willing and able to stimulate free-wheeling discussions

Three years ago the New York based Fund for Peace established in Washington, D. C., the Center for Defense Information—an institution capable of serious, independent examination of the assumptions, fact, and policies of the Department of Defense. For the first time since Billy Mitchell suggested battleships were obsolete (he proved it by sinking a battleship with a bomb, but lost his job) and, for the first time since Admiral Hyman Rickover started pushing for a nuclear submarine force (he kept his job only because of congressional pressure), there now exists in the Center for Defense Information an institution competent to promote discussion of defense policies based on fact and independent judgments. The Center utilizes the experience of retired career military officers from the Army, Navy, Air Force, and the Marines. It has developed its own sources of information. The result is that finally there exists a non-governmental competence which does not salute and say 'yes sir' every time the Pentagon demands another aircraft carrier or overseas base.

The Board of Directors of the Fund for Peace, with Randolph Compton as Chairman, is now supporting the creation of a similar institution in the field of foreign affairs. Its sponsorship of the new Washington Institute for International Policy is based on the belief that U.S. foreign policies should be subject to debate and constructive criticism by non-government and non-establishment experts—knowledgeable individuals who do not respond to a Secretary of State or President's proposed foreign policy by saying: "yes sir, you have the facts, the expertise, and good judgment."

The newly organized Institute for International Policy is to be an organization able

- to collect information on foreign policy, relying in part on the thousands of former foreign policy experts now retired from international service (from the World Bank or from the U.S. foreign service, for example);
- to disseminate the information collected;
- to provide a forum for widespread discussion of foreign policies and their effect on international society; and
- to help Americans see the world as it is, not as we would like to believe it is.

In bringing the knowledge and judgments of a wide variety of foreign-policy-experienced individuals to bear on the foreign policies of the United States as well as of other nations, policies can be examined from fresh points of view. The "open and responsible" debate which Rockefeller called for can be based on information from sources other than the government; the policy judgments of the experts can be examined and leavened by experts and members of the public not beholden to official decisions; and the consultation by executive officials with the Congress can acquire a significance not heretofore possible.

Foreign policies not able to command the respect and support of the people of a democracy can be disastrous. Democratic debate and full consultation are essential to the formulation and conduct of the foreign policy of the United States. It is time to question support of age-old but persistent traditions as that military weapons are the key to understanding the relations among nations. ☐

The sewerless society

The flush toilet took civilization down the wrong road a century ago, and the problem grows worse each year; now, a quiet revolution in disposal methods promises a more sensible alternative, but it will take concerted public effort to bring it about

Harold H. Leich

To a visitor from another planet it would seem incredible that human beings who are intelligent enough for space travel solve their problems of personal hygiene by putting their body wastes into the public drinking water and then spend billions in futile efforts to restore the water to its original condition. It is scientifically possible but financially infeasible to restore water completely once it has been contaminated by body wastes.[1]

The flush toilet, long considered the very symbol of modern sanitation and progress, wastes about 40 percent of all water piped into the home and befouls waterways from the muddy Potomac to the blue Mediterranean. Despite the money and energy spent on sewage treatment, traditional disposal methods are at a dead end—more sewers for more people, more billions for more treatment plants, more refined methods of intensive treatment, and still the effluent damages water quality downstream. Adverse effects of present sewage disposal systems include the following:

- *Risk of transmitting diseases to water users downstream.* Chlorination effectively kills bacteria in the drinking water but there is less certainty about killing viruses, which cause diseases such as polio and infectious hepatitis and are suspected as one cause of cancer.[2] Recent findings in the Mississippi River basin indicate that chlorination to kill bacteria from toilets upstream may itself create carcinogenic substances in the drinking water.[3]
- *Waste of large quantities of purified drinking water to carry away small quantities of body wastes.* The average toilet flush uses about five gallons of water. In one year the typical user of a flush toilet contaminates 13,000 gallons of fresh water to carry away 165 gallons of body wastes.
- *Enormous expenditures for sewer lines and treatment plants.* A recent estimate states that complete sewage treatment for one small river basin—the Potomac—will cost $1.4 billion in addition to the substantial sums already invested in recent decades. But even this huge expenditure will not make the river swimmable. (In 1965 President Johnson, in signing a water quality bill, pledged to reopen the Potomac for swimming by 1975.)
- *Accelerated eutrophication of lakes and estuaries.* Even advanced treatment does not completely remove the dissolved unwanted nutrients from the effluent.
- *Leakage of raw sewage.* Aging sewer lines can allow leakage into the ground water supply or into surface waters.[4] The reverse, ground water leaking into sewer lines, can

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also happen.

- *Build-up of large amounts of sewage sludge.* The sewage sludge produced at the Blue Plains Plant serving the Washington, D.C., area, for example, is expected to reach 2,400 tons a day when fully operational. Rural residents do not look with favor on receiving the growing waste load.[5]

In an effort to overcome environmental problems caused by the flush toilet, sanitation authorities have developed excessively centralized systems—the collection of human wastes from hundreds of thousands and even millions of people into one place for disposal. Such centralized systems are vulnerable to power failures, equipment breakdowns, employee strikes, and by-passing during flooding or high water—all of which can send millions of gallons of raw sewage downstream.

The present situation is bad enough, but what of the future? In 1970 the Council on Environmental Quality estimated that municipal sewage loads would nearly quadruple within 50 years. The Environmental Protection Agency received estimates in 1973 from municipalities for more than $60 billion to build sewage treatment facilities by 1990, but cautioned that the estimates might include inflated costs because 75 percent of the amount would come from Federal funds. Winfield M. Kelly, Jr., of Prince George's County, Md., stated that 1985 sewage-flow estimates for a huge proposed regional treatment plant for that county exceeded the available water supplies for the area by 321 million gallons a day.

Thus it is increasingly apparent that sanitary engineers and public health officials took the wrong turn in the road in the nineteenth century when they encouraged widespread adoption of the flush toilet. The tens of billions now programmed in this country for sewage disposal merely take us further down the same road. Sanitation authorities should also take a hard look at the kitchen garbage grinder, which puts a heavy load of organic wastes into the public water supply. Now is the time to stop this new threat to our rivers, lakes, and oceans.

The solution to these water-supply and sanitation problems seems elementary: (1) body wastes should not be put into the public water supply, and (2) sewage disposal systems should be decentralized with wastes disposed of in the individual house, apartment building, or factory. Before the days of 'modern' plumbing, societies had systems for recycling body wastes back to the land—crude, perhaps, but more ecologically sound for the long run than flushing them into the water supply of the next town downstream.

Before the days of 'modern' plumbing, societies had systems for recycling body wastes back to the land —crude, perhaps, but more ecologically sound for the long run than flushing them into the water supply of the next town downstream.

A quiet revolution in sewage disposal is fortunately now taking place in Sweden and the United States. New methods promise to solve the sewage problem by disposing of wastes on or near the site without the use of large quantities of water. They offer us the chance to decentralize human sanitation without going back to the evils of the outhouse. If widely adopted they would drastically cut down water consumption and could eventually eliminate costly sanitary sewers and treatment plants.

Waterless toilets were developed several decades ago for owners of homes where water and sewer connections were not available. Because it is now forbidden by law to discharge body wastes into harbors and other confined waters there is a need for sewage disposal systems aboard inland and ocean-going vessels, and several large companies are now investing millions in this field. It is only a step to adapt this new marine technology for use in year-round dwellings and high-rise buildings ashore.

There are at least seven different types of sewerless toilets or sewage disposal systems on the market or under development at this time. (The author has not personally tested any of these systems.)

- **Incinerating Toilets.** Several Swedish and U.S. companies make individual incinerating toilets, fired by oil, electricity, or piped or bottled gas.[6] They quickly reduce body wastes to a sterile ash. Prices range from $400 to $600 a unit. Tens of thousands have already been installed in vacation homes, houseboats, and other places where a sewer connection is not possible, such as the watch tower of a penitentiary, forest lookout towers, a high hut on the Matterhorn, and a basement recreation room where the sewer line is above floor level. But these devices are not just being installed in vacation houses or at unusual sites, an increasing number are being installed in year-round houses, especially in Australia, New Zealand, and Japan. Incinerating toilets have also been selected to serve crews building the Alaska pipeline, so body wastes will be disposed of under extremely cold conditions.

These devices consume considerable amounts of energy but completely solve the water pollution problem. Inevitably though there is some release of gases and odor to the air. One manufacturer, however, is working on a new unit that will discharge nothing but carbon dioxide and water vapor to the air.

- **Composting Toilets.** A Swedish inventor, Rikard Lindström, has developed a composting toilet that uses no energy or water and depends on the mild heat of com-

Some cities, such as Chicago, have found ways to recycle the sludge from their waste treatment plants. But they are in a minority, and the process is far from cheap.

posting to drive off the water content in the wastes. A large fiberglass container about nine feet long with a slanting bottom is installed in the basement, and two vertical chutes lead down from the floor above, one for the toilet and one for kitchen garbage. When the unit is installed a layer of peat moss, grass clippings, and soil is placed along the bottom to begin the composting process. Pathogenic organisms in the wastes are slowly consumed by aerobic bacteria in the compost. A natural draft system ventilates the wastes, keeps the process aerobic rather than septic, and carries away any odors through a vent pipe rising above the house roof. When the lid to the toilet or garbage chute is raised, air moves down into the basement container and thus odors do not come into the house.

The container and its contents need no attention during the first two years; then the dried compost, which has slowly worked its way down the slanting bottom, is ready for the garden or other disposal. It measures only about five percent by volume of the waste materials deposited many months before. Tests by Swedish health authorities have shown it to be free of pathogenic organisms.

More than a thousand of these units have been installed in Scandinavia, mostly in vacation homes, and recently a U.S. company obtained rights to make and sell the units in this country.[7] The price ranges around $950 to $1,300, depending on size of the container; mass production may bring the price down, however.

The Clivus-Multrum company in Sweden is working to adapt the system to apartment houses, by means of lateral pipes enclosing electrically operated screw-augers which will move the wastes to a central container for composting.

Other competing manufacturers in Scandinavia and the United States are beginning to make composting toilets. These use smaller containers in the base of the commode itself rather than in the basement and, therefore, need electrical heating and ventilating systems to maintain the composting process. Prices run from about $300 to $700 each.

- **Biological Toilets.** One U.S. manufacturer makes a recycling toilet which is based on biological principles of waste digestion: body wastes and toilet tissues are turned into water by the action of enzymes and bacteria, both aerobic and anaerobic.[8] Flushing after each use is done by a hand pump. The company states that the resultant effluent, about one quart a week for each user, is clear, odorless water containing no pathogenic organisms. It is readily disposed of in a small drain field or dry well beside the house. No sludge removal is needed; the only maintenance is the weekly addition of a freeze-dried package of enzymes and bacteria, at a cost of 25 cents, and a renewal of the charcoal filters once every two years.

The toilets come in a variety of forms for use in mobile homes, boats, vacation houses, and construction sites. Many are installed deep in coal mines. The company states that they are readily adaptable for high-rise buildings. Prices are in the $300 to $400 range; one model is now listed in the current Sears Roebuck catalog. More than 4,000 are in use and production is running at 1,000 a month.

Ordinarily no water, electrical, or sewer connections are needed; but if the unit is to operate in temperatures below 50° F, an electrical heating element is added to allow the biological action to continue.

Montgomery County, Maryland, is trying out 18 of these units in "Project Inside," to replace outdoor privies in rural homes under a grant from the National Water Demonstration Project. In July 1975 a similar project in Fairfax County, Va., with 16 units in rural homes was reportedly failing because of complaints from some of the users about odors. The manufacturer believes the problem was caused by the use of chlorine-based cleansers in the commode.

An Irish company, Biodynamics Ltd., makes a biological toilet which apparently operates on principles similar to the one described above.

- **Oil-Flushed Toilets.** A large U.S. company, Chrysler Corp., has developed a closed-loop toilet system that uses a white, low-viscosity mineral oil as the flushing medium. Wastes from the commodes are carried by the flushing oil to a gravity separation tank where the oil floats to the top and the water-saturated wastes sink to the bottom. The oil is drawn off from the top through a series of filters and is then recirculated to the commodes. It remains clear and odorless indefinitely and bacteria are controlled to nearly zero. Wastes are periodically drained from the bottom of the tank and incinerated to a sterile ash or they can be held for other disposal: removal to a municipal treatment plant or aerobic digestion and drying. One advantage of the system is that it can be installed in existing toilets.

This system has U.S. Coast Guard approval and many marine installations have already been made; for example, a tug boat in New York harbor, a Corps of Engineers snag boat, and a service vessel with a crew of 20 working with oil rigs in the North Sea. Land installations have often been made at parks and campgrounds, and the system can be used for high-rise buildings. The toilets are also installed at a naval barracks in Annapolis and at two Army posts.

A Japanese company, Sumitomo Shoji Kaisha Ltd., has recently been licensed to manufacture the equipment in Japan for the residential, commercial, and marine markets.

Another U.S. company, Monogram Sanitation Products, is marketing an oil-flushed system that has been tested and accepted for use in visitor centers in many national parks and forests. It is also well adapted for single-family homes, where a 400-gallon holding tank has the capacity to store the contents of 6,000 toilet flushes (or 4.1 flushes per day per person), which is a capacity sufficient for one year for a family of four. When filled the tank is pumped into a truck for disposal. A professor of architecture has suggested to the company that it develop a home methane generator to utilize the wastes. Unusual site installations include a four-fixture toilet 500 feet down in a Kansas salt mine and rest-room facilities on an island in a water reservoir in California. The equipment is being installed in a new community surrounding a lake in Connecticut.

- **Household Collection Systems.** The adoption of waterless indoor toilets with the wastes going directly into canisters has been suggested.[9] Twice a week the canisters would be tightly sealed and placed outside for collection by municipal workers. In one case the canisters would go to a bio-gas plant nearby, where the wastes would be used for generating methane gas and the spent material would be spread as a fertilizer. In the other case the canisters would be made of biodegradable material so they could be buried in farmland, where the wastes would serve as a deep fertilizer. Odors in the house would be controlled by spreading powder or dirt over each deposit.[10] These suggested systems are not in

A guide to sewerless toilets

The following is a partial listing, by brand name and manufacturer, of various types of sewerless toilets which are currently being marketed.

Incinerating Toilets

DESTROILET, La Mere Industries, Inc., Walworth, Wis. 53184
ECETT, AB Hakanssons Industrier, Box 126, 662 00 Amal, Sweden
ELE KTRO STANDARD, AB, Box 26, 641 00 Katrineholm, Sweden
ELONETTE, AB Elonette, Grevgatan 50, 114 58 Stockholm, Sweden
INCINOLET, RPMC, 2639 Andjon St., Dallas, Texas 75220
INCINOMODE, Incinomode Sales Co., Box 879, Sherman, Texas 75090
PYROLET, Continental Commerce Limited, 10721 W. Capitol Drive, Milwaukee, Wis. 53222

Composting Toilets

BIU-LET, Bio-Utilities, Inc., Box 135, Narberth, Pa. 19072
ECOLET, Recreation Ecology Conservation of United States, Inc., 9800 W. Blue Mound Rd., Milwaukee, Wis. 53226
MULLBANK, Inventor AB, Prastgatan 42, 831 00 Ostersund, Sweden
MULL-TOA, Hans Kr. Nielsen, Sorkedalsveien 22, Oslo 3 Norway
SANITERM, AB Electrolux, Luxbacken 1, 112 62 Stockholm, Sweden

Biological Toilets

BIO-FLO, Pure Way Corp., 301-42nd Ave., East Moline, Ill. 61244
BIOCYCLE MK 1, Biodynamics Ltd., Camac Buildings, Ballymount Rd., Clondalkin Co., Dublin, Ireland

Oil-Flushed Toilets

AQUA-SANS, Chrysler Corp., Space Div., Box 29200, New Orleans, La. 70189 .
AWUA-SANS, Sumitomo Shoji Kaisha Ltd., Tokyo, Japan
MAGIC FLUSH, Monogram Sanitation Products Inc., Box 92545, Los Angeles, Ca. 90009

Vacuum Systems

ELECTROLUX VACUUM SEWAGE SYSTEM, Electrolux, Environmental Systems Div., 105 45 Stockholm, Sweden
ENVIROVAC, Colt Industries, 701 Lawton Ave., Beloit, Wis. 53511
SANIVAC, Sanivac Div., National Homes Corp., Lafayette, Ind.
VACU-BURN, Jered Industries, Inc., 1300 S. Coolidge Rd., Birmingham, Mich. 48008
VACU-FLUSH, Mansfield Sanitary Inc., Perrysville, Ohio 44864

Aerobic Tanks

AQUA-ROBIC, Waltec Industries Inc., Wallaceburg, Ontario, Canada
BI-A-ROBI, Charles E. Traverse, Jr., Box 133, Hamlin, Pa. 18427
CROMAGLASS, Cromaglass Corp., Box 1146, Williamsport, Pa.
FLO-THRU, On-Site Sewerages Inc., Box 567, Lafayette, Ind. 47901
FLYGT, FLYGT Corp., Box 857, Norwalk, Conn. 06856
JET, Jet Aeration Corp., 750 Alpha Dr., Cleveland, Ohio 44143
MULTI-FLOW, Multi-Flow Inc., 500 Webster St., Dayton, Ohio 45401
NAYATIC, Nayatic Sciences Inc., Box 860, Valley Forge, Pa. 19482

operation and are cruder than the others listed here, but they are cheaper to install and may find a place in rural areas.

New non-polluting technology is solving the problems of sewage disposal and promises to eliminate the need for expensive sanitary sewers and treatment plants.

The concept of a waterless indoor toilet is not new; it goes back to the 'earth closet' used in Britain before the 'water closet' or flush toilet took over.[11] In 1872 a British author, William Eassie, penned what he called a "Hymn of Praise to Mother Earth":

> The advantages claimed for the earth system are many, and amongst others the following: that it leaves unpolluted the natural springs and watercourses; that it allows the rainfall to be collected in a pure state; that it is a great saving of water, and, unlike the water closet, is independent of winter frosts; that it is inexpensive and not apt to get out of order; that it dispenses with underground drainage, or considerably narrows it down, and robs it of its dangers; that it generates no smell; that it is an auxiliary to health, or rather a prevention of zymotic disease; and that it is a source of profit to the patron, either in money or in increased farm or garden crop.[12]

- **Vacuum Systems.** Several Swedish and American companies make toilet systems that use the vacuum principle to transport body wastes from the toilet bowl to a collection tank for disposal.[13] An electric pump maintains a vacuum in the line. More than 20,000 of such toilets are now in use throughout the world. The system uses only a liter of water per flush, since differential air pressure moves the wastes through the line. The system can be adapted to a variety of needs from single-family houses to apartments, factories or whole new towns. In addition to greatly reducing water consumption, the system uses pipes that are much smaller than in traditional systems and they can run uphill where necessary. Ultimate disposal of wastes from a vacuum system can be through on-site incineration, removal to a rural area for use as fertilizer, or piping to a municipal treatment plant.

The system is well adapted to marine use, and several U.S. and Canadian destroyers have been so fitted. The new *Delta Queen*, a steampowered excursion boat on the Mississippi, uses 320 vacuum toilets, and an island development off the west coast of Florida will have the toilets installed in 60 new houses. A classroom building at the University of Michigan will use 80 vacuum toilets. The system is often placed in mobile units that can be moved temporarily to camp grounds or athletic events.

- **Aerobic Tanks.** The problems of septic tanks are well known. Recently a number of U.S. companies have marketed disposal systems that depend on aerobic rather than anaerobic action to digest waste materials in the tanks and drain fields. They differ in cost and design but have in common the use of small electric pumps that periodically mix air into the tanks to break up solids and speed up digestion of the wastes. In contrast to a septic tank, the aerobic action does not generate foul odors,[14] and the effluent going into the tile drain field carries a charge of dissolved oxygen which helps to prevent clogging of the field. Some manufacturers claim that their systems do not build up a load of sludge that would require periodic removal as with a septic tank. Others claim merely that the cycle for pumping out sludge is greatly lengthened as compared with a septic tank.

The Maryland Environmental Health Administration concluded in 1974 a two-year trial of aerobic systems from six manufacturers in suburban homes in Oakland in the Alleghenies. This area was chosen in order to give the units a severe test because of the cold climate, heavy rainfall, low winter temperatures, and heavy clay soil. The units were installed at homes where septic tanks had failed. The test was considered to be successful, although one unit failed to meet standards.[15] The Health Administration has recommended a number of aerobic systems to county health departments, which have final approval authority.

Some public health authorities look with skepticism on the new aerobic systems because they require a greater degree of care by the householders than do septic tanks.[16] One answer to this problem is to set up a public maintenance service with costs charged to the householder.

True enough such aerobic systems use as much water going through the flush toilets as do traditional methods and thus cannot match the water-saving benefits of the six preceding categories. But one manufacturer, Multi-Flow, Inc., has developed an aerobic-tank system which filters the effluent to the point where it can be safely recycled back to the flush toilets, with consequent water saving in the home.

Another cure for failing septic systems has been introduced by another U.S. company.* This involves biological rather than electromechanical action. For many years efforts have been made to grow bacterial cultures that could be placed into septic tanks to stimulate the digestion of body wastes. These efforts often failed because the bacteria died during transportation from the producer to the home. A new biological discovery keeps the bacteria alive but in a dormant state for an indefinite period. Then when they are placed into a septic tank,

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*LLMD, Micro-bio Product Company, 632 N. Washington St., Alexandria, Va. 22314.

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sewage lagoon, or other waste receptacle, the bacteria become active and feed on the wastes. Each gallon of liquid supplied by the company is said to contain about 50 billion microorganisms, both aerobic and anaerobic. By their action in attacking body wastes and grease, they accelerate the digestion process and eliminate foul odors. After they are initially established in a waste receptacle, additional quantities are added periodically to maintain the biological action.

One advantage of vacuum toilets and aerobic or septic tanks over the other categories described above is that they can be designed to dispose of all wastewater from the home or larger building: 'black water' from the toilets and 'gray water' from basins, sinks, baths, and washing machines. But if black water can be safely disposed of by the five other systems above, then it should be a fairly simple matter to develop home filtration devices to cleanse the gray water since such drainage does not carry a heavy load of pathogenic organisms. After filtration the water could be used for non-drinking purposes such as watering lawns and washing cars, with further reduction of domestic water use. Any excess could be led away to storm drains or streams with no ecological damage. One company is devoting a major research effort to the development of such a home filtration system.

New non-polluting technology is thus solving the problems of sewage disposal and promises to eliminate the need for expensive sanitary sewers and treatment plants. It may be that not one of the systems described above will be the best answer. But on the other hand perhaps each one of these systems will find a niche in the sewerless society of the future, or perhaps some wholly new idea will sweep the field. What is highly encouraging is that ingenious people have already produced what seems to be workable systems and manufacturers are investing millions to perfect and market them.

Concern about the wasteful use of energy is one element that must be kept in mind in evaluating these new systems. On this element the highest rating goes to the Swedish composting toilet, since it requires no electricity, gas, pumped-in water, or any other form of energy once it is installed. The biological toilet is a close second; it requires no fuel or water, except for an initial amount, but does require the weekly addition of bacteria and enzymes. The two household collection systems use no energy in themselves but require the expenditure of energy to operate the bi-weekly collection system. One of the systems might pay for itself by the production of methane gas, which could be sold for household or industrial use.

All other devices in the categories above require some use of electricity, oil, or gas and, in addition, the vacuum toilet uses small amounts of pumped-in water. It would take a detailed study of each system in actual use by many families for a period of months to make valid rankings among them, and to compare their total energy requirements in a city of, say, 100,000 people with the great amount of energy needed for pumping millions of gallons of fresh water and sewage a day through the traditional centralized disposal system of that city.

The economics of the new equipment may favor a sewerless society over traditional methods. In some places it now costs a builder from $1,000 to $1,700 to connect a new house to a sewer line, in addition to the cost of commodes and waste lines in the house. Such costs would go a long way to pay for the new devices. But even if present costs were doubled, the new equipment would be worth installing because of its great ecological benefits.

Clearly the transition to the sewerless society will be a task which will take decades. As a first step the new devices could be installed where no sewer lines exist; and they could be installed as original equipment in our growing suburbs and new towns. Finally they could be used as replacement equipment in existing cities and towns, block by block, with the help of public funds in whole or in part.

In the meantime, what about the tens of billions already programmed for new sewer lines and treatment plants? We have no choice but to proceed with building these facilities, even though they will be only an interim clean-up measure. When the sewerless society arrives sewage treatment plants can be converted to cleaning off-street storm drainage, in itself a heavy ecological burden for rivers and lakes to absorb.

While awaiting the sewerless society we can make better use of centralized sewage sludge than stockpiling it in old quarries, burning it, or dumping it in the ocean off our bathing beaches.[17] For many years Milwaukee has dried it and sold it in 50-pound bags as a garden fertilizer under the name "Milorganite." The U.S. Department of Agriculture has an encouraging experiment under way at its Beltsville, Maryland, station to compost sludge from the Blue Plains treatment plant in Washington. The sludge is heated for 10 days and is then mixed with wood chips and composted for about three weeks. The temperature in the heaps rises to 150° F, and the resultant product is said to be odorless and nearly sterile. Nevertheless the White House turned down an offer to spread the finished compost on the south lawn.

A few experiments are under way to pipe liquid sewage to farmlands and forests, where it is sprayed as a fertilizer.[18] This has a double advantage: the waste is recycled to the land and the water, filtered by the soil, replenishes the water table. But the long-range effect is not yet clear; there may be an undesirable build-up of heavy metals and toxic chemicals in the soil, and air drift of pathogenic organisms is possible. Such land treatment for all municipal sewage would require immense tracts of land near large cities; for example, about 124,000 acres near Washington, D.C., and more than one million acres near New York City.[19]

Agricultural use of sludge and compost from household sources like vacuum, oil-flushed, and composting toilets would involve less danger of accumulating heavy metals and toxic chemicals in the soil than would sludge from municipal plants since the harmful contaminants generally come from factories that dump their wastes into municipal sewers. But regulations to discourage householders from dumping paints, pesticides, and crankcase oil into their toilets might still be needed.

Another use of sludge would be for methane production. Plans for the new headquarters building of the U.N. Environment Programme, Nairobi, Kenya, call for generating methane gas from many waste sources such as leaves and manure.

Sewerless systems would offer developing nations the chance to avoid the sanitation errors of the industrialized ones. These systems would also be far more economical to install, if the expenses of sewer lines and treatment plants are taken into account. As an Environmental Protection Agency representative in New York City said, "If we had to do it all over again, we might do it differently, but we're kind of stuck with the system now."[20] With no investment in sewer lines or treatment plants, the developing nations can leapfrog the flush toilet and go right to the new non-polluting technology. The government of Nigeria has approved the use of the biological toilet.

It is encouraging that more attention is now being paid to the major environmental problems created by the flush toilet. Several articles in widely read publications have recently discussed this subject. At the School of Architecture at McGill University in Montreal, study of alternatives to the flush toilet identified 60 alternative systems.[21] On the other hand, the voluminous 1973 study of sewage problems by the National Water Commission did not contain a word about sewerless disposal methods.[22]

As the next step, official U.S. agencies might take a more positive view of the new technology. Certain public bodies such as the Maryland state government, Montgomery County, Md., and Fairfax County, Va., should be commended for their open-minded testing of new sewerless devices. The EPA has an experiment under way to try an incinerating toilet system in an Eskimo village in Alaska. But a more concerted effort, taking only a minute fraction of the funds being devoted to building sewers and treatment plants, would be fruitful.

A major federal research project should be launched in view of the great ecological and financial benefits to be achieved if a sewerless solution is found.

For example, EPA could coordinate a nationwide testing program through state and local sanitation agencies to insure that every promising sewerless device is tested on a large scale in actual use and carefully monitored. Part of the evaluation would involve relative costs of installation and operation and energy needs. The results could then be discussed at a national conference of sanitation authorities and, hopefully, measures would be taken to encourage rapid adoption of the successful systems.

But if the tests show that no existing commercial product can do the job, then a major federal research project should be launched in view of the great ecological and financial benefits to be achieved if a sewerless solution is found. Surely the brilliant scientists of the National Aeronautics and Space Administration and the National Bureau of Standards have a contribution to make on waterless waste disposal. Federal millions are going into energy research. Sewerless waste disposal, however, is equally important to our nation's future as well as to modern society which must soon adopt methods for non-polluting disposal of human body wastes for the world's growing population.

Notes

1. A task force headed by Ralph Nader, however, concluded that after the United States had spent $3.5 billion in a 15-year water clean-up effort, the level of filth had not been reduced in a single major body of water.

2. Washington Post, July 29, 1971; International Herald Tribune, Nov. 13, 1972.

3. Washington Star-News, Nov. 8, 1974.

4. At the height of the 1975 tourist season the National Park Service closed Crater Lake National Park in Oregon because several hundred people became ill when sewage leaked into the water supply (Washington Post, July 12, 1975).

5. "Containing the Flow of Sewage Sludge," *Environmental Science and Technology*, Aug. 1974, p. 702.

6. See p. 41 for names and addresses of companies who make incinerating toilets.

7. Clivus Multrum USA, 14 A Eliot St., Cambridge, Mass. 02138.

8. The 'Bio-Flo' recycling toilet is manufactured by the Pure Way Corp., 301-42nd Ave., East Moline, Ill. 61244.

9. Robert Mueller, "Getting Rid of Sewage—Isn't There a Better Way?" *Environmental Action*, 6:22 (March 29, 1975), 3; and John Shuttleworth, "Make Waste Pay Off," Washington Star, (July 30, 1975). The latter article described a methane-generation system for rural areas which would not require household collections because the wastes would be utilized on the site.

10. Harold H. Leich, "A Challenge to the Environment Pro," *Environmental Science and Technology*, 5:1 (Jan. 1971), 11.

11. Sam Love, "An Idea in Need of Rethinking: The Flush Toilet," *Smithsonian Magazine*, May 1975, p. 61. Love describes a British earth closet of around 1860, invented by the Rev. Henry Moule, which sifted dry earth into the toilet bowl when a lever was pulled. See also George R. Stewart, *Not So Rich As You Think* (New York: New American Library), p. 35.

12. *Healthy Houses, a Handbook to the History, Defects, and Remedies of Drainage, Ventilation, Warming, and Kindred Subjects* (New York: D. Appleton and Co., 1872), p. 81.

13. The 'Envirovac' sewage system, for example, which is manufactured by Colt Industries in Beloit, Wisconsin 53511.

14. *On Site Waste Water Disposal for Homes in Unsewered Areas.* Small Scale Waste Management Project, University of Wisconsin, Sept. 1973, p. 10.

15. Merrill B. Glasser, "Garrett County Home Aeration Wastewater Treatment Project," Draft (Baltimore, Md.: Environmental Health Administration, May 1975).

16. Anthony T. Voell and Richard A. Vance, "Home Aerobic Wastewater Treatment Systems, Experiences in a Rural County," *Ohio Home Sewage Conference Proceedings*, Ohio State University, 1974, pp. 26-36.

17. For an excellent discussion of ocean dumping, see Tracy Kidder, "Sludge," *Atlantic Monthly*, April 1975, pp. 62-70.

18. For example, "Using the Land for Sewage Disposal," *World*, Dec. 19, 1972, p. 48; and Paul W. Eastman, "The Muskegon County, Mich., Waste Water Management System," *Potomac Basin Reporter*, Interstate Commission on the Potomac River Basin, Oct. 1973, p. 4.

19. Mid-Atlantic Region, Environmental Protection Agency, *Draft Environmental Impact Statement for the District of Columbia Water Pollution Plant*, April 1972.

20. Kenneth Walker, as quoted in New York Times, July 26, 1971.

21. Witold Rybczynski and Alvaro Ortega, *Stop the Five Gallon Flush*, (4th ed.; Montreal: Minimum Cost Housing Group, School of Architecture, McGill University, March 1973).

22. National Water Commission, *Water Policies for the Future*, Final Report to the President and to the Congress, Washington, D.C., June 1973. Another voluminous study by David Zwick and Mary Benstock, with an introduction by Ralph Nader, also did not contain a word about sewerless disposal methods (*Water Wasteland* (New York: Grossman Publishers, 1971)).

The nuclear industry's secret weapon for reducing fatalities from power plant accidents

DO NOT GO GENTLE INTO THAT RADIATION ZONE

David Dinsmore Comey

Can large numbers of people be evacuated successfully to escape the airborne radioactive cloud released by a serious nuclear power plant accident?

The U.S. Atomic Energy Commission thinks so.* Its "Reactor Safety Study" (WASH-1400), released in draft form in August 1974, assumed that 50 percent of the population living within 20 miles of the reactor would be evacuated successfully within 2 hours, and 90 percent would be evacuated within 8 hours.[1] Largely due to this assumption, the maximum number of civilian fatalities estimated by WASH-1400 is only 2,300, considerably less than the 45,000 predicted in the previous Commission study done in 1964–65.[2]

As the remainder of this article will demonstrate, there are many reasons why the Commission's assumptions about successful evacuation are overly optimistic. Take for instance its 20-mile radius for evacuation. The American Physical Society's review of WASH-1400 concluded that evacuation would have to extend to a distance of 60 kilometers from the reactor (37.3 miles).[3]

Much of Chicago is within 37.3 miles of Commonwealth Edison's nuclear power plant at Zion, Illinois. George Day, assistant director of civil defense for the state of Illinois, has said, "What's my plan to evacuate Chicago? I don't have one. There's no way you can evacuate Chicago."[4] The Illinois director of civil defense, E. Erie Jones, said: "The alternative is to find some way to avoid the difficulty. For nuclear plants, the obvious answer is more careful siting. I can't believe anybody gave careful consideration to the location of the Zion plant. If Zion came up for approval this moment, it would not be approved for that location. It has a pretty terrifying potential."[5]

Yet the Commission recently granted a construction permit for the Bailly nuclear plant in Indiana, less than 30 miles from downtown Chicago, and directly adjacent to the Indiana Dunes National Lakeshore which has up to 87,000 daily visitors. The Commission's Atomic Safety and Licensing Board dismissed the evacuation problems by saying the park superintendent could "work it out." The U.S. Court

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*The Nuclear Regulatory Commission assumed the regulatory responsibilities originally vested in the Atomic Energy Commission when the Commission was split into two agencies in January 1975. In order to avoid confusion I have simply referred both to the old AEC and the new NRC as 'the Commission.'

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of Appeals for the Seventh Circuit replied, "It strains credulity to expect that this problem will work itself out and it is ridiculous to in effect say that it should be left to the future."[6] The Court ordered a permanent halt to the Bailly plant's construction.

Although the Commission counts heavily on evacuation to hold down fatalities in WASH-1400, its legal requirements for evacuation plans are so lax as to constitute a clear-cut violation of its statutory obligations under the Atomic Energy Act of 1954 to protect the public health and safety.

Its regulations do not require utilities applying for a nuclear plant license to submit detailed evacuation plans.[7] Responsibility is left up to state and local agencies, yet the Commission licenses plants in states where evacuation plans are virtually non-existent or clearly inadequate. A utility need only state it has made all necessary arrangements with public authorities and provide a minimal outline of the proposed plans.

Even when plans exist, Commission inspectors find the utilities not complying with them. For example, a 1975 Commission inspection of Commonwealth Edison's Zion plant found no evidence of any coordination with the state and local civil defense authorities, the Zion police, or local hospitals since 1972. The plant's emergency plan had not been kept up to date, and lists of emergency telephone numbers were not correct.[8] A 1975 Commission inspection of Commonwealth Edison's Dresden Units 1, 2 and 3 found the same deficiencies.[9] At Quad-Cities Units 1 and 2 not only was the emergency phone list out of date, but Commonwealth Edison had not even executed required agreements with the Illinois Department of Public Health or the local fire departments, and local law enforcement agencies and off-site medical personnel were found in need of retraining.[10]

Even when plans are being complied with, partial test drills reveal severe inadequacies. The state of Minnesota recently carried out a mock emergency warning of residents living within a 3-mile radius of the Monticello plant. The state's director of emergency services, Wes Lane, concluded: "We're not prepared. I expected communications problems, and I got them. Most of the alternative communication systems lead back to a telephone, and the telephone boards were jammed with calls during much of the exercise. . . . Everything looked good on paper until we tried it out."[11] The Minnesota Pollution Control Agency's report on the drill found that information provided by the nuclear plant staff and the U.S. Weather Service was totally inadequate for the state climatologist to determine the height, width, length, dispersion and pathway of the hypothetical radioactive cloud. Furthermore, Health Department monitoring teams had no communications capability and received no information from the plant as to the supposed location of the radioactive cloud.[12]

A 3-hour mock drill by the state of Oregon last summer at the Trojan nuclear plant revealed similar problems. Radiation monitoring personnel had to submit their findings from roadside pay phones because they had no radio-telephones in their cars. One volunteer was told by plant staff to "go west." He drove 52 miles to the Pacific Ocean, and phoned in, asking, "Is this far enough?" The leader of the Commission's evaluation team, Harold W. Gaut, called the drill a "success," despite findings that local agencies failed to coordinate adequately, that confusion existed at evacuation centers, and that there were too few trained technicians.[13]

During the non-mock incident last March at the Browns Ferry nuclear plant in Alabama, considerable deficiencies in the emergency plans surfaced, despite numerous drills by state of Alabama agencies over the past several years. Evacuation of the county's residents was the responsibility of the civil defense coordinator; he told Commission inspectors: "I heard about the fire at Browns Ferry on the morning of Monday, March 24, 1975 [two days later]. No one in the civil defense system notified me or attempted to do so."[14] The county sheriff said: "I heard about the fire at the Browns Ferry plant after it was over. . . . I have not had any updating of procedures proposed to me since the initial plan was outlined in 1972. I do not have a copy of the emergency plan."[15]

The above are not isolated instances. The situation at all nuclear plants across the country has reached the point where even the Commission's normally tolerant Advisory Committee on Reactor Safeguards (ACRS) recently felt compelled to send a letter to William A. Anders, Commission Chairman,

I'm beginning to worry, all my mail is running 4 to 1 in *favor* of my positions on nuclear reactors.

warning of inadequate accident instrumentation, a lack of action criteria, incomplete state response plans, lack of means for verifying that protective actions have actually been carried out, and other serious deficiencies in nuclear plant emergency plans.

A major loophole, ignored by the ACRS, is that 15 of the 53 operating nuclear plants are not required to meet the Commission's emergency plan regulations because the plants went into operation before the regulations were published on December 24, 1970. Even this is not interpreted straightforwardly. At the Point Beach nuclear plant in Wisconsin, Unit 2 did not get its full-powered operating license until April 1973, yet the plant is not required to conform to 10CFR50 Appendix E,[16] because Unit 1 received its operating license just prior to the December 24, 1970 publication of those regulations.

Compliance by these 15 reactors would not require redesigning the plants or retrofitting expensive equipment, simply the creation of adequate plans and periodic drills to test them. The fact that the Commission does not require this is evidence of its regulatory philosophy.

The U.S. Environmental Protection Agency's Office of Radiation Programs feels that "Continual testing of the emergency plans, as authentically as possible, is needed to determine whether it will work practically and to determine needed adjustments."[17] Feedback from the public at large concerning details of the plan can be invaluable, because "Many times emergency plans are written by individuals who have no real experience in emergencies and little or no knowledge of how people behave during an emergency."[18] Thanks to drills, the TVA made three major revisions of its nuclear emergency plans, running to more than 100 pages.[19]

Yet, Oregon is the only state that requires dissemination of nuclear plant evacuation plans to the public.[20] The Commission policy is precisely the opposite: it seeks to avoid providing public information on evacuation plans in order to avoid creating concern.[21]

This is probably counterproductive. People are more likely to respond in an emergency if they have been thoroughly informed of the consequences of failing to comply. This is particularly true in the case of radiation, which cannot be seen and is not felt until long after a fatal exposure has occurred. People may not be inclined to evacuate their homes if their only source of information has been utility and Commission news releases on how safe nuclear plants are. Moreover, there is no authority to force people to leave their homes in the event of a nuclear accident, and most evacuation plans play down the dangers: "Personnel assisting in the evacuation of the public will counsel them that they are in no danger but are being moved for their own safety."[22] I have my doubts whether a farm family with several hundred animals to care for would abandon them in response to such a limp warning.

Recent petitions by 30 public interest groups ask state public service commissions to require utilities to insert nuclear accident evacuation instructions in customer billing statements once a year. Another petition, filed by Martin A. Rogol on behalf of the national Public Interest Research Group (PIRG),[23] asks for strengthened Commission regulations and annual public evacuation drills of a 7-degree sector radiating out from the nuclear plant; at the maximum distance of 40 miles, this arc would be 4.8 miles wide.[24]

It is not clear at this time whether the Commission will change its policy and bring about public participation in evacuation planning.[**] The utilities are on record against it. As A. David Rossin, a spokesman for Commonwealth Edison, recently put it: "We're very hesitant to raise the public's attention to evacuation plans. Our policy is not to get people uptight about something that will never happen in a predicted way, anyway. Public drills are a bad idea because until an accident actually occurs nobody knows which way the wind will be blowing; nobody knows what time it will occur. We don't schedule our accidents."[25]

Thus, the Commission seeks to reassure the public about the safety of nuclear plants by projecting minimum accident consequences due to 90 percent effectiveness of evacuating large numbers of people.

The effectiveness of these plans can be assured only by full public participation through mass educational efforts and frequent drills.

The nuclear industry and the Commission refuse to encourage such widespread public participation for fear of diminishing the public acceptability of nuclear power plants.

It is a disturbing circularity.

[**] Citizens wishing to support or challenge the PIRG petition may address comments to the Chief, Docketing and Service Section, Office of the Secretary, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555.

Notes

1. Atomic Energy Commission, "Reactor Safety Study—An Assessment of Accident Risks in U.S. Commercial Power Plants," WASH-1400 Draft (Washington, D.C.: The Commission, Aug. 1974).

2. The suppressed Brookhaven National Laboratory study. See John G. Fuller, *We Almost Lost Detroit* (New York: Readers Digest Press, 1975) for a detailed account of this study.

3. American Physical Society, "Report to the APS by the Study Group on Light Water Reactor Safety," presented at the 1975 spring meeting of the Society. See *Reviews of Modern Physics,* vol. 14, supplement 1, 1975, p. S46.

4. William J. Lanouette, "Evacuation After a Nuclear Accident: Can It Be Done?" *National Observer,* July 12, 1975.

5. Casey Bukro, "Where Can Radiation Victims Go for Aid?" Chicago Tribune, Nov. 7, 1974.

6. U.S. Court of Appeals, Seventh Circuit, *Porter County Chapter, Isaak Walton League of America, Inc., et al.,* v. *AEC,* No. 74-1751 (April 1, 1975), p. 32.

7. Title 10, Code of Federal Regulations, Part 50, Appendix E, section III.

8. U.S. Nuclear Regulatory Commission, RO Inspection Reports 050-295/74-18 and 050-304/74-18 (Jan. 25, 1975), pp. 6, 8, 10.

9. NRC, RO Inspection Reports 050-010/75-01, 050-237/75-02, and 050-249/75-02 (Feb. 25, 1975), pp. 3, 11.

10. Atomic Energy Commission, RO Inspection Reports 050-254/74-07 and 050-265/74-04 (June 14, 1974), pp. 1, 5, 13.

11. Lanouette, "Evacuation After a Nuclear Accident."

12. Terry Wolkerstorfer, "Report Questions Preparedness for Disaster," Minneapolis Star, June 10, 1975.

13. "Atom Plant Holds Mock-Blast Test," New York Times, Aug. 19, 1975.

14. David Dinsmore Comey, "Chronology of a Nuclear Near-Miss," Chicago Tribune, Aug. 31, 1975.

15. David Dinsmore Comey, "The Incident at Browns Ferry," *Not Man Apart,* Mid-September 1975.

16. AEC, RO Inspection Reports 050-266/74-04 and 050-301/74-04 (April 2, 1974), pp. 2-3; and Title 10, Code of Federal Regulations, Part 50, Appendix E, section III.

17. Environmental Protection Agency, *Evacuation Risks—An Evaluation,* EPA 520/6-74-002 (Washington, D.C.: The Agency, June 1974), p. 49.

18. EPA, *Evacuation Risks.*

19. Testimony of Ernest Belvin, Division of Environmental Planning, Tennessee Valley Authority in transcript of Advisory Committee on Reactor Safeguards Environmental Subcommittee Meeting on Emergency Plans, July 26, 1974, p. 31.

20. Oregon Revised Statutes, 453.595.

21. "Public Not Advised of Evacuation Test," Prince Frederick (Md.) Recorder, April 25, 1974.

22. Kewaunee Nuclear Plant Emergency Plan, "Offsite Emergencies," p. G-II-11.

23. Copies of the petition are available for $2 prepaid from PIRG, 1832 M St., N.W., Suite 101, Washington, D.C. 20036.

24. Lou Sirico, "Citizens Demand Improved Evacuation Procedures," *Critical Mass,* Aug. 1975.

25. Lanouette, "Evacuation After a Nuclear Accident."

Case study of a meltdown

Reviewed by **Samuel H. Day, Jr.**

We Almost Lost Detroit. John G. Fuller (Reader's Digest Press, 1975, 272 pages, $8.95).

Chronicle of the Fermi reactor accident makes good medicine for any who may feel that all's well on the reactor safety front

Sooner or later someone was bound to write a nuclear safety book called *We Almost Lost Detroit*. John G. Fuller's effort doesn't live up to the promise of the subject or the title, but it is a significant book and it is well worth reading.

Fuller, a novelist and playwright, actually started out to write a novel about a nuclear power plant meltdown. But when he began to look into the subject, and especially when he came across some Atomic Energy Commission (AEC) documents on nuclear safety, he decided quite rightly that the truth would make a better story than fiction.

The result is a chronicle of a meltdown that really happened—at the big Enrico Fermi breeder reactor plant on the outskirts of Detroit on October 5, 1966—told in the context of the longstanding nuclear safety issue. On the exciting engineering drama of the rise and fall of the Fermi plant he superimposes the equally fascinating political drama of how government and industry dealt with the question of nuclear safety.

There is an important lesson in what happened at the Fermi plant. Conceived in the early 1950s by the Detroit Edison Company, and in particular by its ambitious president, Walker L. Cisler, it was vigorously promoted by the AEC (especially Lewis Strauss, chairman under President Eisenhower) as part of a plan to get private enterprise involved in atomic energy. Despite the warnings of a small and generally timorous collection of knowledgeable scientists and engineers, industry and government plunged headlong into an untried technology to the ultimate tune of $130 million. The result was an accident which fatally crippled the plant and very nearly led to a catastrophe.

Fuller tells that story well, recounting not only the chain of events at Fermi but also earlier and somewhat similar mishaps at the National Reactor Testing Station in Idaho, the Canadian experimental reactor station at Chalk River, Ontario, and the British reactor station at Windscale. He exercises an author's license in the selection of these episodes from a long history of normal and uneventful reactor operations, but his point is forcefully made and well taken: Things can go unexpectedly wrong in a nuclear reactor just as easily as anyplace else.

In the light of the rising public debate over the risks and consequences of major accidents in nuclear reactors, this is an important point to remember. None of the accidents discussed by Fuller at Fermi or elsewhere brought consequences of the scale which have been projected as possibilities by repeated studies. But Fermi, at least, came close, and the potential for catastrophe exists in each of the reactors now being built in growing numbers in the United States and elsewhere. That point is often lost in the plethora of official statistics pointing to the low risks.

The most recent of the comforting reassurances has come in the form of a lengthy study (the Rasmussen Report) prepared under the auspices of the old Atomic Energy Commission and endorsed by the new Nuclear Regulatory Commission which now has responsibility for nuclear safety. The report scales down the consequences of a major accident and likens the risk to that of a meteor landing in a big city. Fuller's detailed account of the AEC's efforts over the years (often in collusion with industry) to manipulate and suppress risk and consequence data will be instructive to those who may be inclined to take these comforting reassurances at face value.

Having made his points effectively (by letting industry and government make them for him), Fuller goes on to belabor his case. *We Almost Lost Detroit* emerges finally as a sermon on the sins of the nuclear power industry and its champions in government—not just those committed in the construction of the nation's first commercial breeder reactor and in the suppression of the 1964 Brookhaven report on reactor accident consequences, but on the entire, familiar list ranging from the dangers of plutonium theft to the question of radioactive waste disposal. As such, it will be comforting to all those whose arguments against further development of nuclear power it summarizes well. It will be useful and instructive to those many more readers for whom the subject is still too technically forbidding to permit a good grasp of the serious public policy issues which are involved. But it will be lost on all those who are now a part of the problem of technological heedlessness, who may be tragic figures but are not yet prepared to see themselves painted, however delicately, as fools or villains.

Fuller does a good job of explaining how "we almost lost Detroit." He doesn't explain why. But one of these days (hopefully, while Detroit is still around) someone will. ☐

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